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Department  
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National Highway  
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Administration

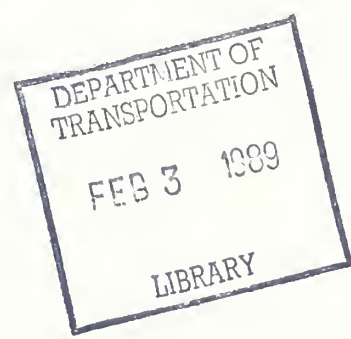
DOT HS 807 335  
Final Report

January 1988

*Sankey, J.*

✓ *c.i.e. harmonization*  
**Harminization of MDB.**

**MDB-To-Car-Side Impact Test of A 26° Crabbed  
Moving Deformable Barrier to A 1985 Chevrolet  
Celebrity at 33.1 MPH**



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Technical Report Documentation Page

1. Report No. DOT HS 807 335	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle HARMONIZATION OF MDB MDB-To-Car-Side Impact Test of A 26° Crabbed Moving Deformable Barrier To A 1985 Chevrolet Celebrity At 33.1 MPH		5. Report Date JANUARY 1988	
		6. Performing Organization Code	
7. Author(s) J.W. Sankey, Project Engineer, TRC		8. Performing Organization Report No. 880107	
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15. Supplementary Notes This test conducted as part of VRTC Project No. VRTC-87-0056, Harmonization of MDB.			
16. Abstract  This test report documents a side impact test conducted to evaluate various methods of determining door velocity. Testing was conducted on a 1985 Chevrolet Celebrity 4-door Sedan at the TRC Crash Test Facility, East Liberty, Ohio. The test vehicle was impacted on the left side by a moving deformable barrier, crabbed to 26°, at 33.1 mph. The test was a simulation of a 90° intersection collision with the striking vehicle travelling at 30 mph and the struck vehicle travelling at 15 mph. The test date was January 7, 1988 and the ambient temperature was 14°F.			
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## SECTION 1.0

### PURPOSE AND INTRODUCTION

#### PURPOSE

The main purpose of this test was to evaluate various methods of determining impacted door velocity. The vehicle was tested using conditions not currently contained in a Federal Motor Vehicle Safety Standard.

#### INTRODUCTION

A stationary 1985 Chevrolet Celebrity 4-door sedan was impacted on the left side by a Moving Deformable Barrier (MDB) on January 7, 1988. The test was to simulate an intersection collision with the striking vehicle travelling at 30 mph and the struck vehicle travelling at 15 mph. The orientation angle of the striking vehicle was 90° counterclockwise with respect to the longitudinal axis of the struck vehicle. The leading edge of contact was to be 37 inches forward of the vehicle center of gravity which is defined by accident investigation to be the midpoint of the wheelbase.

To simulate this collision, the MDB was to be towed into the stationary Chevrolet Celebrity at 33.5 mph with the MDB's wheels crabbed clockwise to 26°. The actual test speed was 33.1 mph and the actual leading edge of contact was 35.0 inches forward of the midpoint of the Chevrolet Celebrity wheelbase.

The vehicle was a baseline model with no structural modification. The driver's door and left rear door were unpadded.

Section 2 contains General Test and Vehicle Parameter Data. Section 3 contains data required by R & D. Appendix A contains pre-test and post-test vehicle photographs. Appendix B contains Data Plots.





## SECTION 2.0

### GENERAL TEST AND VEHICLE PARAMETER DATA

The following data sheets describe the General Test and Vehicle Parameter Data.

TEST VEHICLE INFORMATION

VEHICLE MANUFACTURER: General Motors      VIN: 2G1AW19R2F1128708  
MAKE/MODEL: Chevrolet Celebrity      MODEL YEAR: 1985  
BODY STYLE: 4-door sedan      COLOR: Blue  
NHTSA NO.: R & D  
ENGINE DATA: TYPE: transverse CYLINDERS: 4      DISPLACEMENT: 2.5 liter  
TRANSMISSION DATA: Automatic  
DATA VEHICLE RECEIVED: 12/28/87      ODOMETER READING: 51,523  
DEALER'S NAME AND ADDRESS: Graham Chevrolet  
1515 South Main Street  
Bellefontaine, OH 43311

ACCESSORIES:

POWER STEERING	Yes	AUTOMATIC TRANSMISSION	Yes
POWER BRAKES	Yes	AUTOMATIC SPEED CONTROL	Yes
POWER SEATS	No	TILTING STEERING WHEEL	Yes
POWER WINDOWS	No	TELESCOPING STEERING WHEEL	No
TINTED GLASS	No	AIR CONDITIONING	Yes
RADIO	Yes	ANTI-SKID BRAKE	No
CLOCK	No	REAR WINDOW DEFROSTER	Yes
OTHER	None		

REMARKS:

1. IS THE VEHICLE STOCK THROUGHOUT? Yes
2. DOES VEHICLE SHOW EVIDENCE OF PRIOR ACCIDENT HISTORY? No
3. DOES VEHICLE SHOW ANY SIGNIFICANT CORROSION? No
4. CONDITION OF THE FRONT/REAR BUMPER AND FRAME: Good

DATA FROM CERTIFICATION LABEL ON LEFT DOOR FACE OR "B" POST:

VEHICLE MANUFACTURED BY: General Motors  
DATE OF MANUFACTURE: 6/85  
GVWR: 4036 LBS., GAWR: FRONT 2191 LBS., REAR 1845 LBS.

TEST VEHICLE INFORMATION, CONT'D

WEIGHT OF TEST VEHICLE AS RECEIVED (WITH MAXIMUM FLUIDS):

RIGHT FRONT	878 LBS.	RIGHT REAR	502 LBS.
LEFT FRONT	923 LBS.	LEFT REAR	500 LBS.
TOTAL FRONT WEIGHT	1801 LBS.	(64.2% OF TOTAL VEHICLE WEIGHT)	
TOTAL REAR WEIGHT	1002 LBS.	(35.8% OF TOTAL VEHICLE WEIGHT)	
TOTAL DELIVERED WEIGHT	2803 LBS.		

VEHICLE ATTITUDE (ALL DIMENSIONS IN INCHES):

DELIVERED ATTITUDE:	LF 26.7;	RF 26.9;	LR 26.6;	RR 27.1
PRE-TEST ATTITUDE:	LF 27.0;	RF 27.0;	LR 26.2;	RR 26.2
POST-TEST ATTITUDE:	LF 25.1;	RF 25.6;	LR 25.1;	RR 25.2

WHEELBASE: 104.8 INCHES

MAX. WIDTH: 67.8 INCHES

CG = 41.1 INCHES REARWARD OF FRONT WHEEL CENTERLINE

WEIGHT OF TEST VEHICLE WITH REQUIRED DUMMIES AND 46 LBS. OF CARGO:

RIGHT FRONT	865 LBS.	RIGHT REAR	583 LBS.
LEFT FRONT	867 LBS.	LEFT REAR	534 LBS.
TOTAL FRONT WEIGHT	1732 LBS.	(60.8% OF TOTAL VEHICLE WEIGHT)	
TOTAL REAR WEIGHT	1117 LBS.	(39.2% OF TOTAL VEHICLE WEIGHT)	
TOTAL TEST WEIGHT	2849 LBS.		

WEIGHT OF BALLAST SECURED IN VEHICLE TRUNK AREA: 0 LBS.

COMPONENTS REMOVED TO MEET TARGET WEIGHT: None

TEST VEHICLE INFORMATION, CONT'D

VEHICLE TIRE DATA:

RECOMMENDED COLD TIRE PRESSURE: 35 psi

TIRES ON VEHICLE (MFR., LINE, SIZE): Goodyear P185/75R14 Polyester Radial

BIAS PLY, BELTED, OR RADIAL: Radial

PLY RATING: 1 ply

IS SPARE TIRE A "SPACE SAVER": Yes

IS SPARE TIRE STANDARD EQUIPMENT: Yes

DATA FROM "RECOMMENDED TIRE PRESSURE" LABEL ON DOOR, POST, GLOVEBOX, ETC.

VEHICLE LOAD (UP TO CAPACITY): FRONT 35 psi; REAR 35 psi

RECOMMENDED TIRE SIZE: P185/75R14 LOAD RANGE X B,    C,    D

VEHICLE CAPACITY: TYPES OF SEATS: Front bucket  
Rear bench

NUMBER OF OCCUPANTS (DESIGNATED SEATING CAPACITY):   2   FRONT  
  3   REAR  
CARGO LOAD  165  LBS.   5   TOTAL

TOTAL  915  LBS.

TEST VEHICLE INFORMATION, CONT'D

TEST FLUID TYPE: RED STODDARD SOLVENT #2; SPEC. GRAVITY: 0.764

KINEMATIC VISCOSITY: 0.99 CENTISTOKES

"USEABLE" CAPACITY\*: NA GALLONS

TEST VOLUME: 0.0 GALLONS

FUEL SYSTEM CAPACITY (DATA FROM OWNERS MANUAL): NA GALLONS

DETAILS OF FUEL SYSTEM: NA

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ELECTRIC FUEL PUMP: NA

FUEL INJECTION: NA

DOES ELECTRIC FUEL PUMP OPERATE WITH IGNITION SWITCH "ON" AND THE ENGINE NOT OPERATING? NA

\*WITH ENTIRE FUEL SYSTEM FILLED.

TEST VEHICLE INFORMATION, CONTINUED

TEST CONDITIONS

TEST NUMBER: 880107

DATE OF TEST: 1/7/88

TIME OF TEST: 1342

WIND VELOCITY: 5 - 10 mph @ 90°E

HUMIDITY: NA

AMBIENT TEMPERATURE AT IMPACT AREA:

14°F

TEMPERATURE IN OCCUPANT COMPARTMENT:

NA

DRIVER TEMPERATURE:

NA

PASSENGER TEMPERATURE:

NA

SUBJECT VEHICLE DATA

	<u>ACTUAL</u>	<u>INTENDED</u>
TEST WEIGHT (lbs.)	2849	2968
MDB WEIGHT (lbs.)	2995	3000
MDB VELOCITY (lbs.)*	33.1	33.5
IMPACT POINT (ins)**	35.0	37.0

DUMMIES

	RT. FRONT PASSENGER
DRIVER	

TYPE:

SERIAL NO.:

INSTRUMENTATION:

HEAD ACCEL.:

CHEST ACCEL.:

FEMUR L.C.'S:

OTHER:

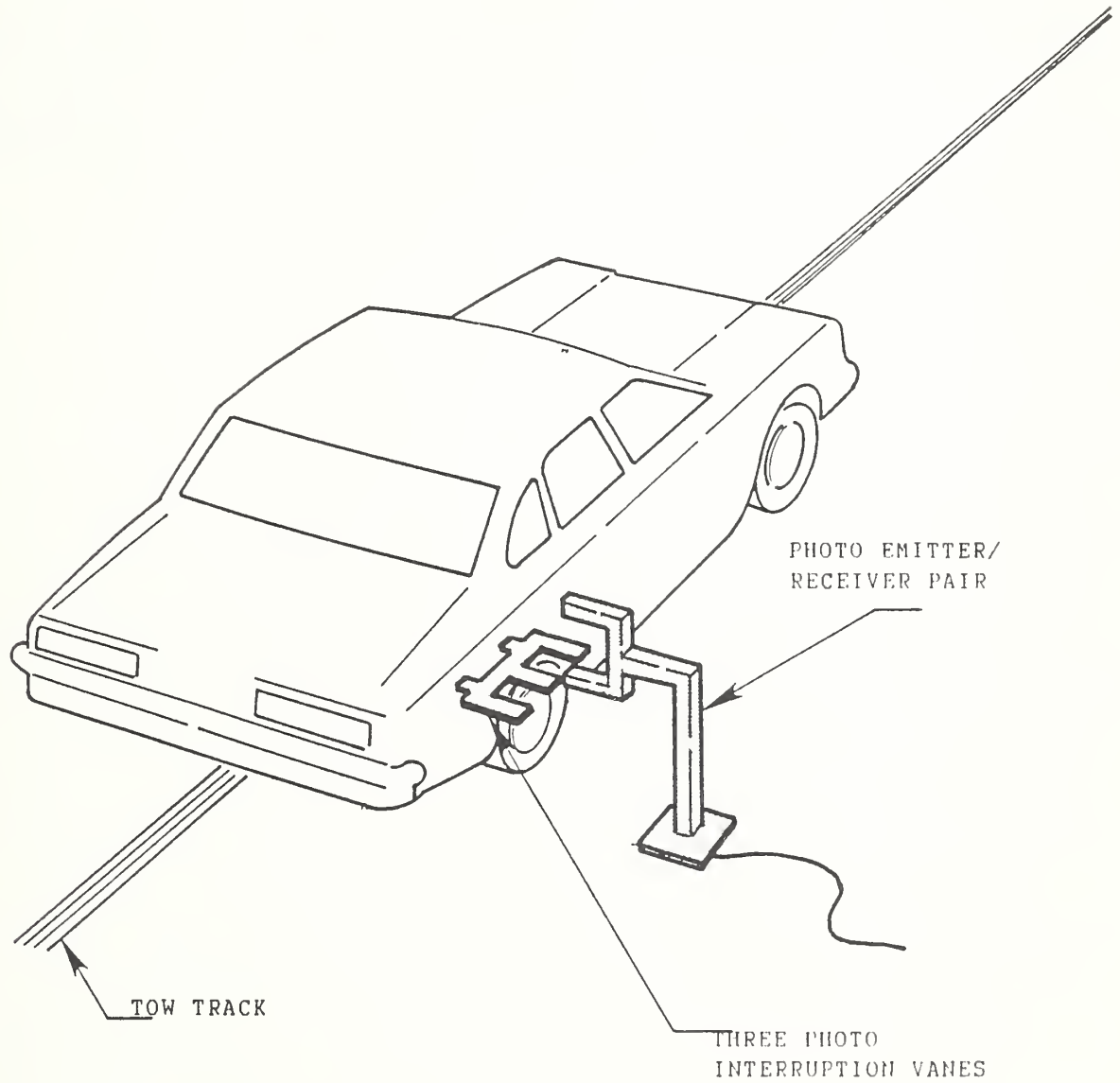
RESTRAINT SYSTEM:

REMARKS: There were no occupant dummies in the vehicle.

\*As measured over final one foot of travel.

\*\*As measured forward of the test vehicle's wheelbase.

IMPACT VELOCITY MEASUREMENT SYSTEM



The final vane clears emitter/receiver two inches before impact.

The vanes have one foot spacing.

#### VEHICLE TEST WEIGHT CALCULATION

Test Weight = Unloaded Delivered Weight +  
                  (Number of Dummies X 174 lbs.) +  
                  Cargo Weight  
                  = 2803 + (0 X 174) + 165 lbs.  
                  = 2968 lbs.

The weight of test vehicle was measured by placing each wheel on a K. J. Law Force Plate.



### TEST ANOMALIES

The vehicle center of gravity yaw rate gyro, VCGV, data did not return to zero and included questionable data spikes.

The left front door (thorax) linear potentiometer, LFDYD1, recorded questionable data after 15 milliseconds due to internal separation in the linear potentiometer.



### SECTION 3.0

#### DATA REQUIRED BY R&D

The following pages are included in this section:

1. Vehicle crush data
2. Vehicle accelerometer location and data summary
3. High speed camera information
4. Transducer information

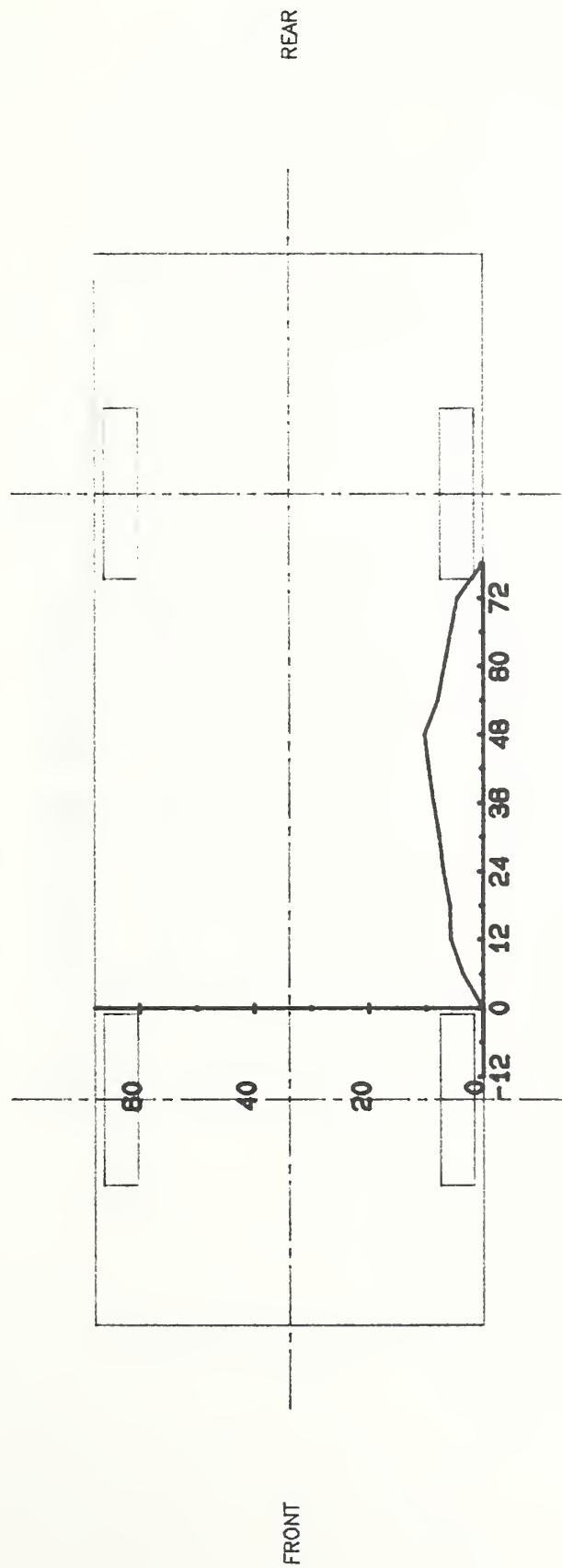
VEHICLE EXTERIOR PROFILES AND STATIC CRUSH  
ZERO DISTANCE AT PROJECTED IMPACT POINT\*

LOCATION	HEIGHT (IN)	6	0	6	12	18	24	30	36	42	48	54	60	66	72	78
PRE-TEST PROFILE (DISTANCE IN INCHES FROM REFERENCE PLANE**)																
Axle Height	11.2	NA	NA	17.9	17.9	17.9	17.9	18.0	17.8	17.8	17.8	17.8	17.6	17.5	17.7	NA
H-Point	20.1	NA	13.7	13.7	13.6	13.5	13.5	13.5	13.5	13.5	13.5	13.6	13.6	13.7	13.8	NA
Mid Door	23.6	NA	14.0	14.1	14.0	13.9	13.9	13.8	13.8	13.8	13.8	13.9	13.9	14.0	14.1	14.0
Window Sill	35.4	16.0	16.1	16.0	16.0	16.0	16.0	15.9	15.8	15.8	15.8	15.8	15.9	16.0	16.1	16.1
Window Top	53.1	NA	NA	NA	NA	NA	NA	23.9	24.1	24.2	24.6	24.7	24.5	24.5	24.5	24.6
POST-TEST PROFILE (DISTANCE IN INCHES FROM REFERENCE PLANE**)																
Axle Height	11.2	NA	NA	21.3	23.5	23.7	24.8	25.6	26.4	27.4	28.0	25.8	24.4	23.1	22.2	NA
H-Point	20.1	NA	15.5	20.8	27.0	28.4	29.0	29.1	29.4	29.0	29.5	29.5	29.5	29.1	26.6	NA
Mid Door	23.6	NA	15.8	22.4	24.9	25.8	26.1	26.6	26.6	26.5	27.1	27.4	27.0	27.1	26.5	19.2
Window Sill	35.4	17.5	17.6	19.5	20.1	24.0	25.1	25.4	25.4	25.5	26.5	26.2	26.1	26.5	25.0	20.2
Window Top	53.1	NA	NA	NA	NA	NA	NA	27.0	27.5	28.5	28.5	28.4	28.8	27.3	26.9	26.6
STATIC CRUSH (IN)																
Axle Height	11.2	NA	NA	3.4	5.6	5.8	6.9	7.6	8.6	9.6	10.2	8.0	6.8	5.6	4.5	NA
H-Point	20.1	NA	1.8	7.1	13.4	14.9	15.5	15.6	15.9	15.5	16.0	15.9	15.9	15.4	12.8	NA
Mid Door	23.6	NA	1.8	6.7	10.9	11.9	12.2	12.8	12.8	12.7	13.3	13.5	13.1	13.1	12.4	5.2
Window Sill	35.4	1.5	1.5	3.4	4.1	8.0	9.1	9.5	9.6	9.7	10.7	10.4	10.2	10.5	8.9	4.1
Window Top	53.1	NA	NA	NA	NA	NA	NA	3.1	3.4	4.3	3.9	3.7	4.3	2.8	2.4	2.0

\* Projected impact point is 37 inches forward of passenger side wheelbase midpoint. Column readings are rear to front from left to right.

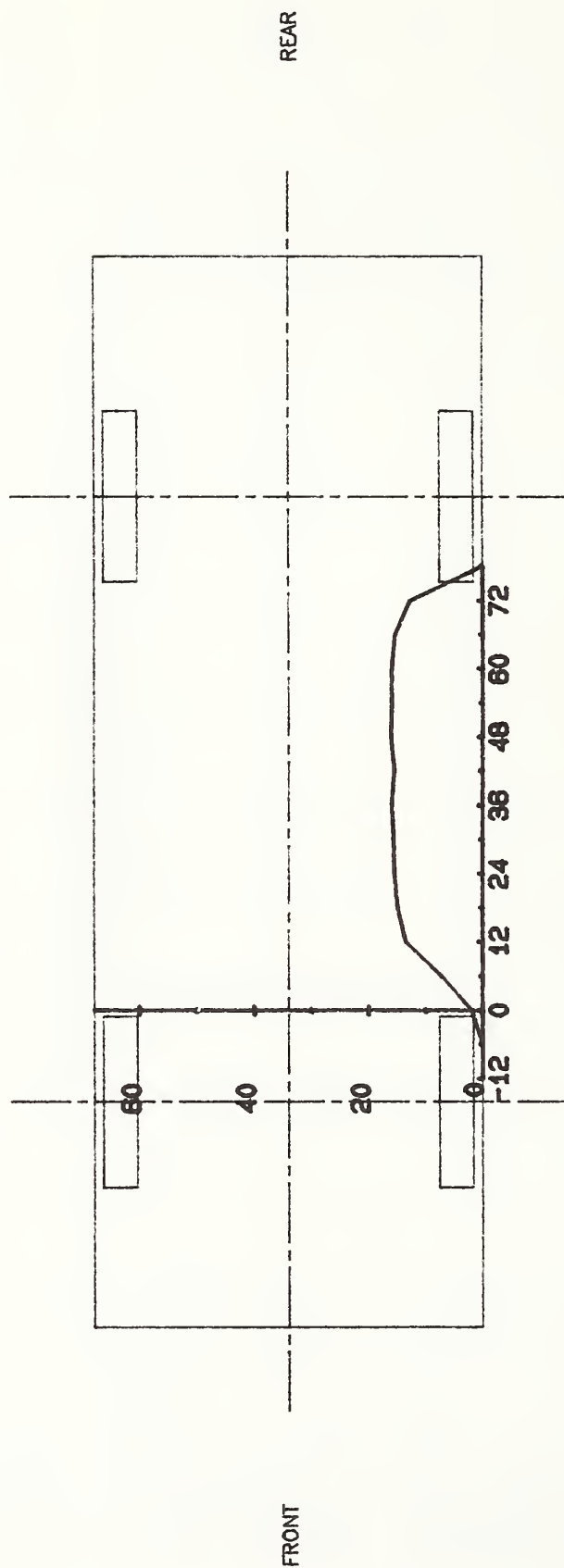
\*\* Reference plane is parallel to and 48 inches from the vehicle longitudinal centerline.

# VEHICLE EXTERIOR STATIC CRUSH PROFILE



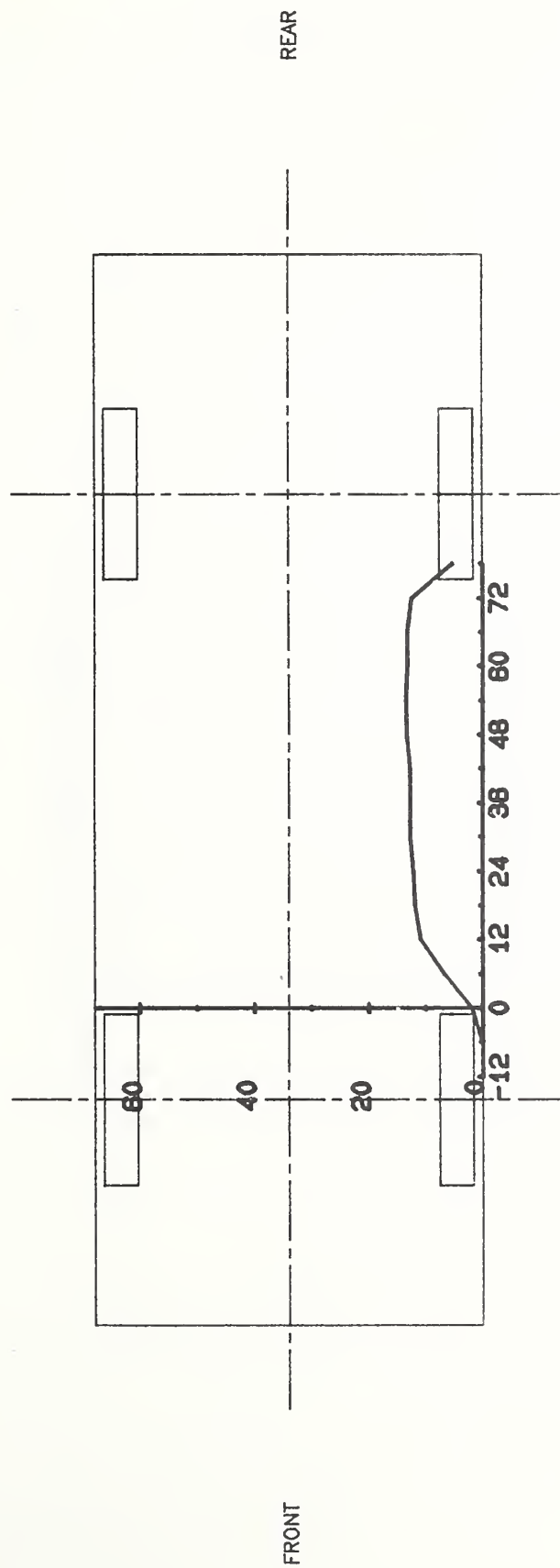
PROFILE LEVEL EQUALS AXLE HEIGHT WHICH IS 11.2" ABOVE GROUND LEVEL  
 (0,0) EQUALS PROJECTED IMPACT POINT  
 SCALE FACTOR EQUALS 0.034

# VEHICLE EXTERIOR STATIC CRUSH PROFILE



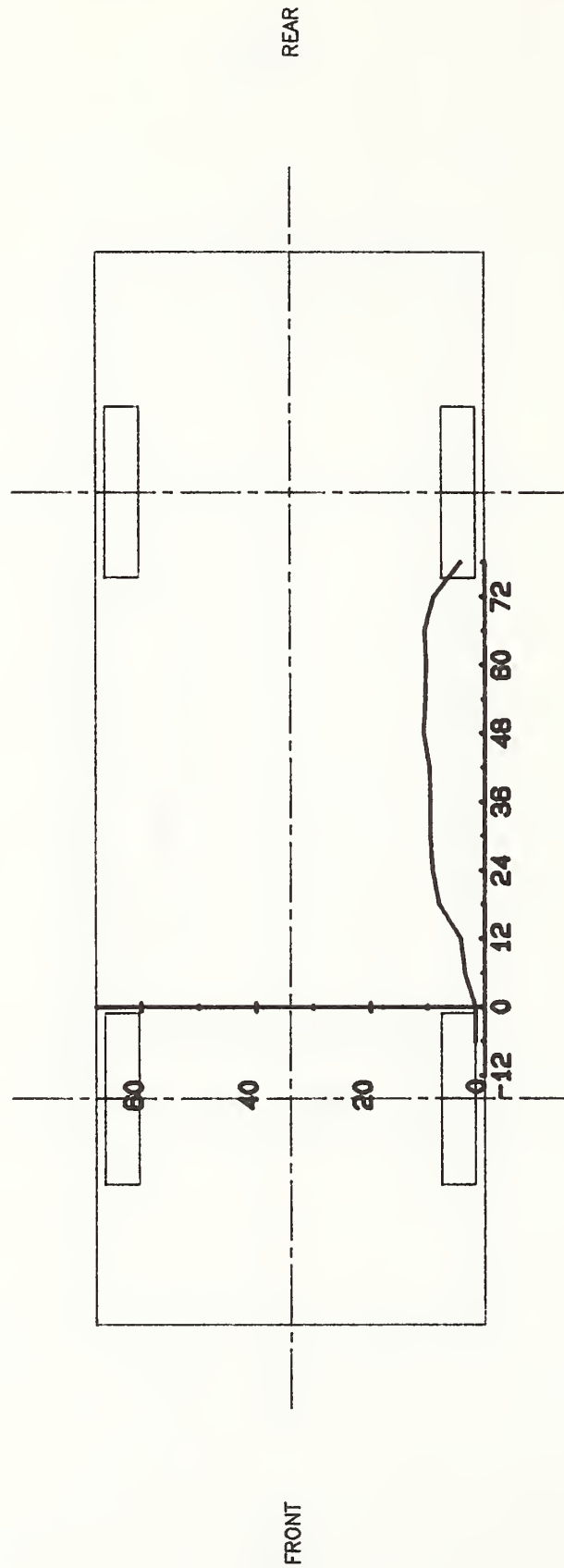
PROFILE LEVEL EQUALS H-POINT HEIGHT WHICH IS 20.1" ABOVE GROUND LEVEL  
 (0,0) EQUALS PROJECTED IMPACT POINT  
 SCALE FACTOR EQUALS 0.034

# VEHICLE EXTERIOR STATIC CRUSH PROFILE



PROFILE LEVEL EQUALS MID DOOR HEIGHT WHICH IS 23.6" ABOVE GROUND LEVEL  
 (0,0) EQUALS PROJECTED IMPACT POINT  
 SCALE FACTOR EQUALS 0.034

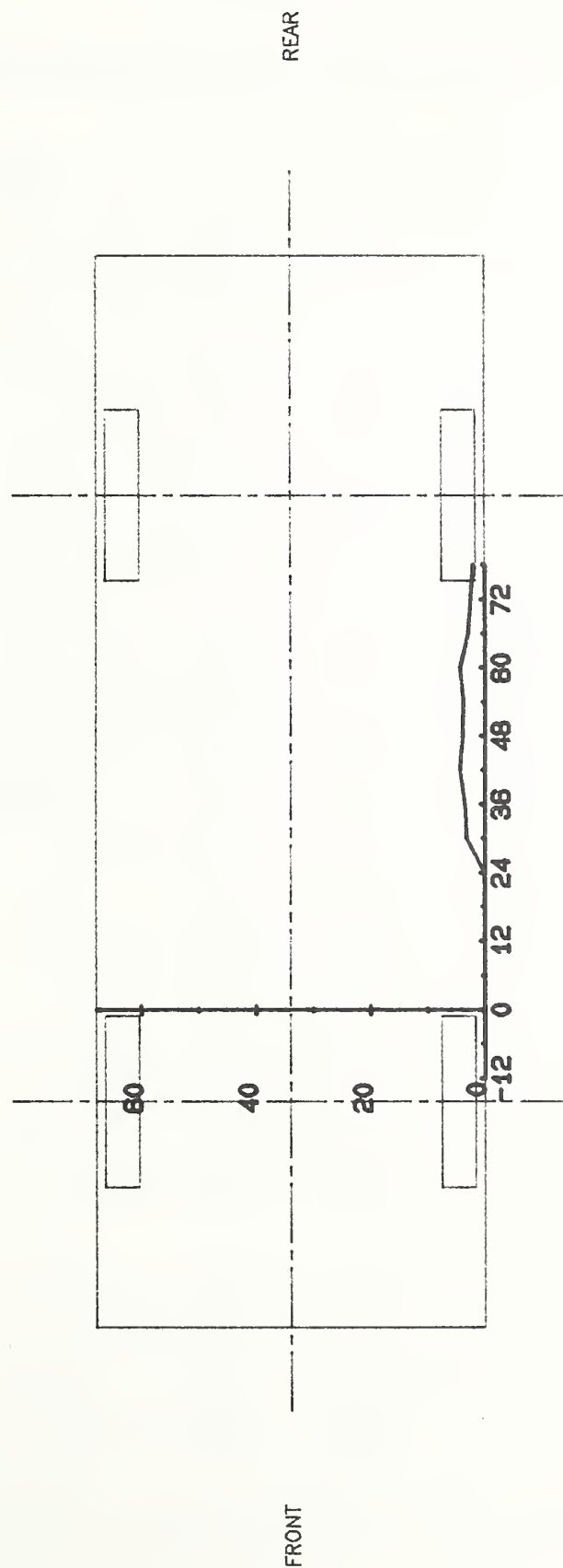
# VEHICLE EXTERIOR STATIC CRUSH PROFILE



PROFILE LEVEL EQUALS WINDOW SILL HEIGHT WHICH IS 35.4" ABOVE GROUND LEVEL  
 (0,0) EQUALS PROJECTED IMPACT POINT  
 SCALE FACTOR EQUALS 0.034



# VEHICLE EXTERIOR STATIC CRUSH PROFILE



PROFILE LEVEL EQUALS WINDOW TOP HEIGHT WHICH IS 53.1" ABOVE GROUND LEVEL  
 (0,0) EQUALS PROJECTED IMPACT POINT  
 SCALE FACTOR EQUALS 0.034

TEST NUMBER 880107

VEHICLE ACCELEROMETER LOCATIONS AND DATA SUMMARY

No.	LOCATION	X*	Y*	Z*	POSITIVE DIRECTION MAX G MSEC		NEGATIVE DIRECTION MAX G MSEC	
1	RIGHT SILL AT FRONT SEAT	112.6	27.0	11.7				
	LONGITUDINAL	$\Delta V = -0.6 \text{ mph @ } 97.5 \text{ msec}$			3.6	60.4	4.1	39.5
	LATERAL	$\Delta V = 13.7 \text{ mph @ } 97.5 \text{ msec}$			21.6	9.1	7.3	70.8
2	RIGHT SILL AT REAR SEAT	97.5	27.0	12.0				
	LONGITUDINAL	$\Delta V = 0.9 \text{ mph @ } 97.5 \text{ msec}$			4.4	60.3	2.4	20.8
	LATERAL	$\Delta V = 15.7 \text{ mph @ } 97.5 \text{ msec}$			23.1	9.4	6.2	70.8
3	REAR DECK OVER AXLE	41.5	0.0	19.6				
	LONGITUDINAL	$\Delta V = -4.0 \text{ mph @ } 97.5 \text{ msec}$			4.2	51.4	7.9	68.8
	LATERAL	$\Delta V = 23.1 \text{ mph @ } 97.5 \text{ msec}$			26.2	30.0	3.1	122.8
4	LEFT SILL AT REAR SEAT	99.1	-27.0	11.8				
	LATERAL	$\Delta V = 16.3 \text{ mph @ } 26.2 \text{ msec}$			75.2	4.5	24.3	13.8
5	LEFT SILL AT FRONT SEAT	112.1	-27.0	11.6				
	LATERAL	$\Delta V = 16.2 \text{ mph @ } 26.6 \text{ msec}$			52.9	4.5	9.5	29.5
6	LEFT FRONT DOOR CENTERLINE	107.3	-28.2	18.9				
	LATERAL	$\Delta V = 16.3 \text{ mph @ } 14.9 \text{ msec}$			110.2	7.8	85.4	16.5
8	MIDREAR OF LEFT FRONT DOOR	90.4	-28.9	19.1				
	LATERAL	$\Delta V = 28.2 \text{ mph @ } 11.5 \text{ msec}$			123.9	6.1	58.5	14.4
9	UPPER LEFT FRONT DOOR CENTERLINE	107.3	-28.9	33.9				
	LATERAL	$\Delta V = 18.4 \text{ mph @ } 30.0 \text{ msec}$			49.5	7.6	23.0	34.0
11	LEFT FRONT DOOR (THORAX)	93.2	-28.2	31.8				
	LATERAL	$\Delta V = 33.8 \text{ mph @ } 41.6 \text{ msec}$			97.3	9.3	33.4	28.6
11	LEFT FRONT DOOR (THORAX) FOAM BLOCK	90.8	-28.2	31.8				
	LATERAL	$\Delta V = 20.7 \text{ mph @ } 26.2 \text{ msec}$			106.5	8.8	64.9	28.1
12	LEFT FRONT DOOR (H-POINT)	93.8	-28.2	19.2				
	LATERAL	$\Delta V = 34.9 \text{ mph @ } 26.6 \text{ msec}$			151.4	8.4	88.6	17.0

TEST NUMBER 880107

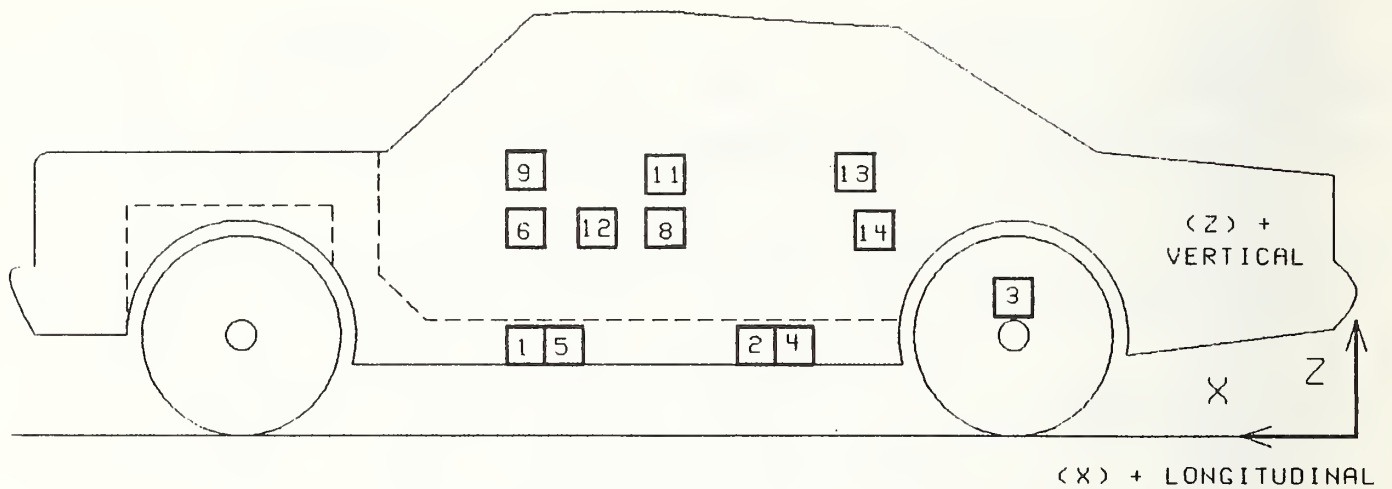
VEHICLE ACCELEROMETER LOCATIONS AND DATA SUMMARY CONTINUED

No.	LOCATION	X*	Y*	Z*	POSITIVE DIRECTION		NEGATIVE DIRECTION	
					MAX	G MSEC	MAX	G MSEC
12	LEFT FRONT DOOR (H-POINT) FOAM BLOCK LATERAL	94.8	-28.2	19.2				
					161.1	7.8	105.5	16.0
13	LEFT REAR DOOR (THORAX) FOAM BLOCK LATERAL	55.2	-28.4	32.9				
					76.4	25.3	61.9	19.5
14	LEFT REAR DOOR (H-POINT) FOAM BLOCK LATERAL	59.2	-28.4	21.8				
					203.2	11.9	37.3	44.4

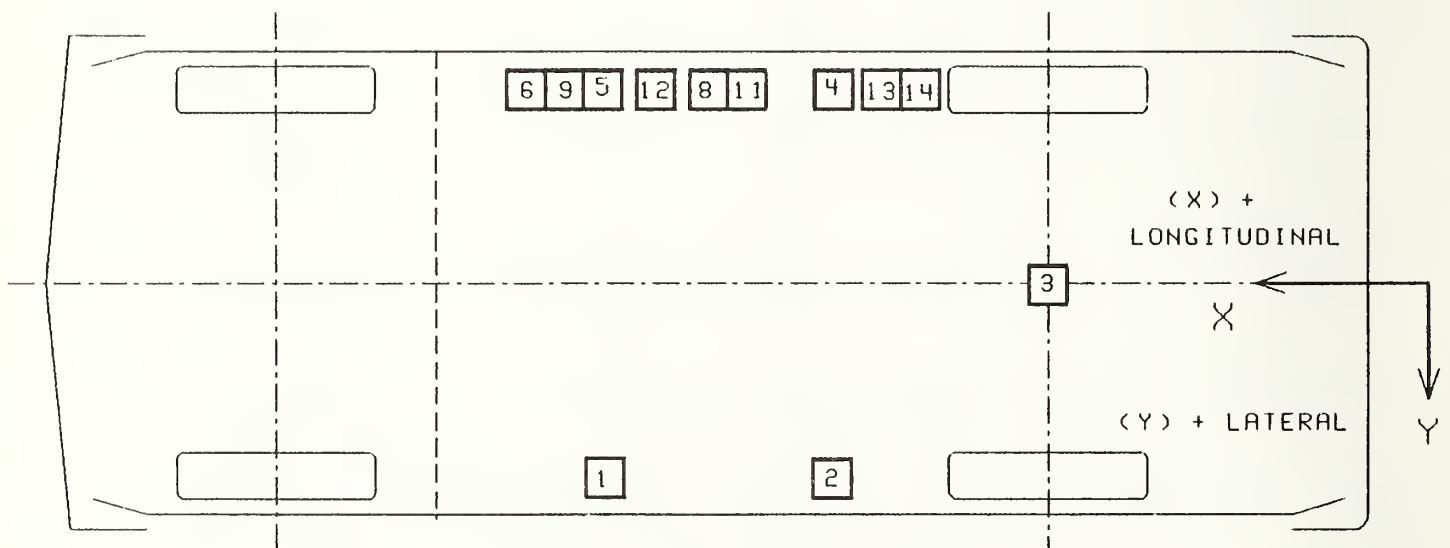
\* ALL MEASUREMENTS OF ACCELEROMETER LOCATIONS ARE IN INCHES.

REFERENCE: X: FORWARD  
Y: RIGHTWARD  
Z: UPWARD

# VEHICLE ACCELEROMETER PLACEMENT



SIDE VIEW



BOTTOM VIEW

TEST NUMBER 880107

VEHICLE POTENTIOMETER LOCATIONS AND DATA SUMMARY

No.	LOCATION	X*	Y*	Z*	POSITIVE DIRECTION		NEGATIVE DIRECTION	
					MAX IN MSEC		MAX IN MSEC	
11	LEFT FRONT DOOR (THORAX) LINEAR POT LATERAL	92.8	-28.0	32.6	13.8	22.1 Y	0.0	0.4 Y
11	LEFT FRONT DOOR (THORAX) STRING POT LATERAL	92.0	-27.2	31.1	10.6	60.8	0.0	0.4
12	LEFT FRONT DOOR (H-POINT) LINEAR POT LATERAL	96.8	-28.0	20.3	12.0	62.9	0.0	2.1
12	LEFT FRONT DOOR (H-POINT) STRING POT LATERAL	96.0	-27.9	19.2	11.4	75.9	0.0	9.5
15	LEFT FRONT DOOR (OUTER) LINEAR POT LATERAL	96.4	-27.5	29.2	0.8	52.8	0.0	3.8

Y See TEST ANOMALIES

\* ALL MEASUREMENTS OF POTENTIOMETER LOCATIONS ARE IN INCHES.

REFERENCE: X: FORWARD  
Y: RIGHTWARD  
Z: UPWARD

# TEST NUMBER 880107

## VEHICLE YAW RATE GYRO LOCATIONS AND DATA SUMMARY

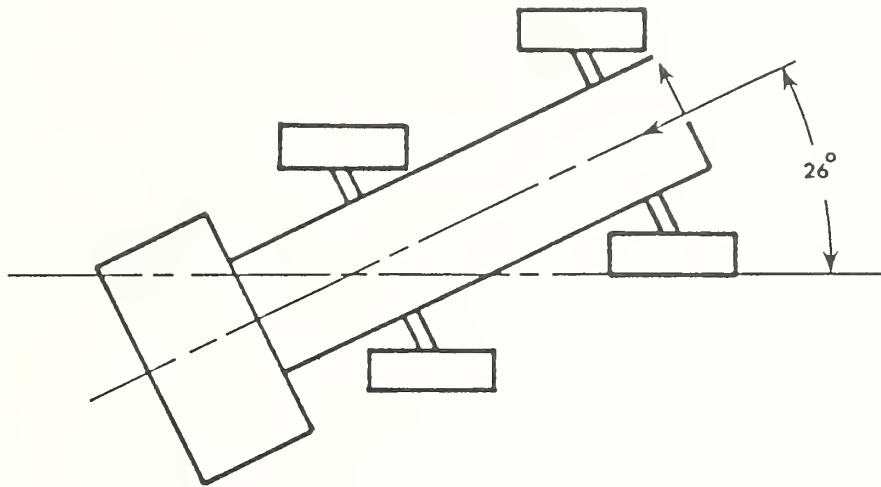
No.	LOCATION	X*	Y*	Z*	POSITIVE DIRECTION		NEGATIVE DIRECTION	
					MAX	MSEC	MAX	MSEC
	YAW RATE GYRO	80.1	0.0	17.6				
	DEG/SEC				100.6	25.8	130.7	60.0

γ See TEST ANOMALIES

\* ALL MEASUREMENTS OF YAW RATE GYRO LOCATIONS ARE IN INCHES.

REFERENCE: X: FORWARD  
Y: RIGHTWARD  
Z: UPWARD

# MOVING BARRIER ACCELEROMETER LOCATIONS AND DATA SUMMARY



NO.	LOCATION	X*	Y*	Z*	POSITIVE DIRECTION		NEGATIVE DIRECTION	
					MAX (g)	TIME (msec)	MAX (g)	TIME (msec)
1.	CENTER OF GRAVITY	73.5	0.0	12.8				
	(LONGITUDINAL)	$\Delta V = -15.8$ mph @ 97.5 msec			1.7	122.5	12.3	19.4
	(LATERAL)	$\Delta V = -4.5$ mph @ 97.5 msec			1.6	58.9	9.5	41.0
	(VERTICAL)				10.8	31.6	4.7	82.5
	(RESULTANT)				15.6	31.5		
2.	REAR FRAME MEMBER	19.4	018.5	12.7				
	(LONGITUDINAL)	$\Delta V = -17.6$ mph @ 97.5 msec			1.9	124.1	14.5	42.0
	(LATERAL)	$\Delta V = 1.6$ mph @ 97.5 msec			3.6	36.2	2.0	106.6

\*Reference: X - Rear Most Point of Frame (+ To Forward), Y - Barrier Centerline (+ To Right), Z - Ground Level (+ To Up)

All measurements of accelerometer locations in inches.

# CAMERA INFORMATION

CAMERA NO.	LOCATION	TYPE	LENS (mm)	SPEED (fps)	PURPOSE OF CAMERA DATA
1	Onboard MDB - Tight	Photosonic 1B	25	500	Closeup of impact point
2	Onboard MDB - Wide	Photosonic 1B	13	498	Vehicle crush
3	Overhead - Tight	Photosonic 1B	25	505	Closeup of impact point
4	Overhead - Wide	Photosonic 1B	8.5	500	Vehicle dynamics
5	Ground Level - Right	Photosonic 1B	25	505	Overall view
6	Ground Level - Left	Photosonic 1B	13	502	Overall view
7	Onboard Windshield	Photosonic 1B	8	773	Potentiometers frt. view
8	Onboard Roof	Photosonic 1B	8	1005	Door/potentiometers



LOCATION OF OFFBOARD HIGH SPEED CAMERAS

---

CAMERA NO.	X	Y	Z
1	0	0	25'
2	0	0	25'
5	24'10"	58'8"	45"
6	-20'11"	-13'	45"

---

Origin of Coordinate System is Point of Impact

\*Reference:

- +X = Forward with Respect to Striking Vehicle's Velocity Vector
- +Y = Rightward with Respect to Striking Vehicle's Velocity Vector
- +Z = Upward with Respect to Striking Vehicle's Velocity Vector



APPENDIX A

PHOTOGRAPHS



Figure A-1. PRE-TEST OVERALL VIEW

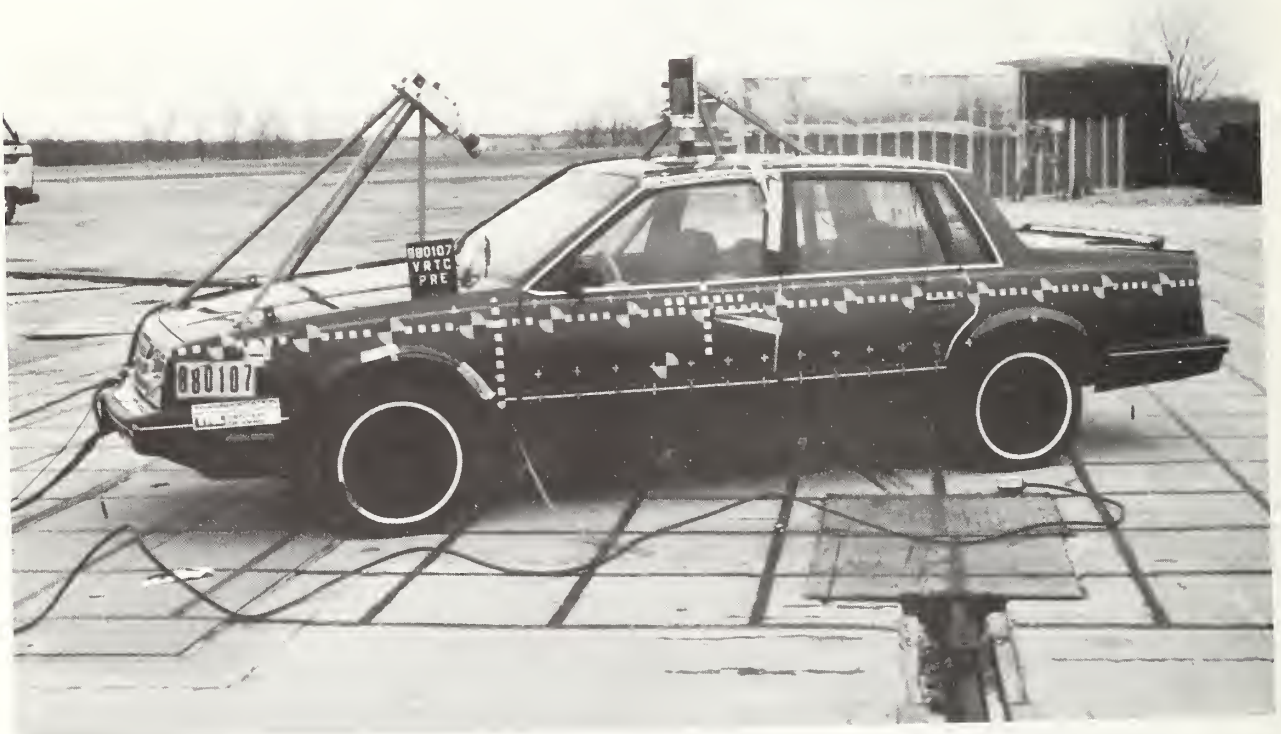


Figure A-2. PRE-TEST LEFT SIDE VIEW  
A-2



Figure A-3. PRE-TEST RIGHT SIDE VIEW

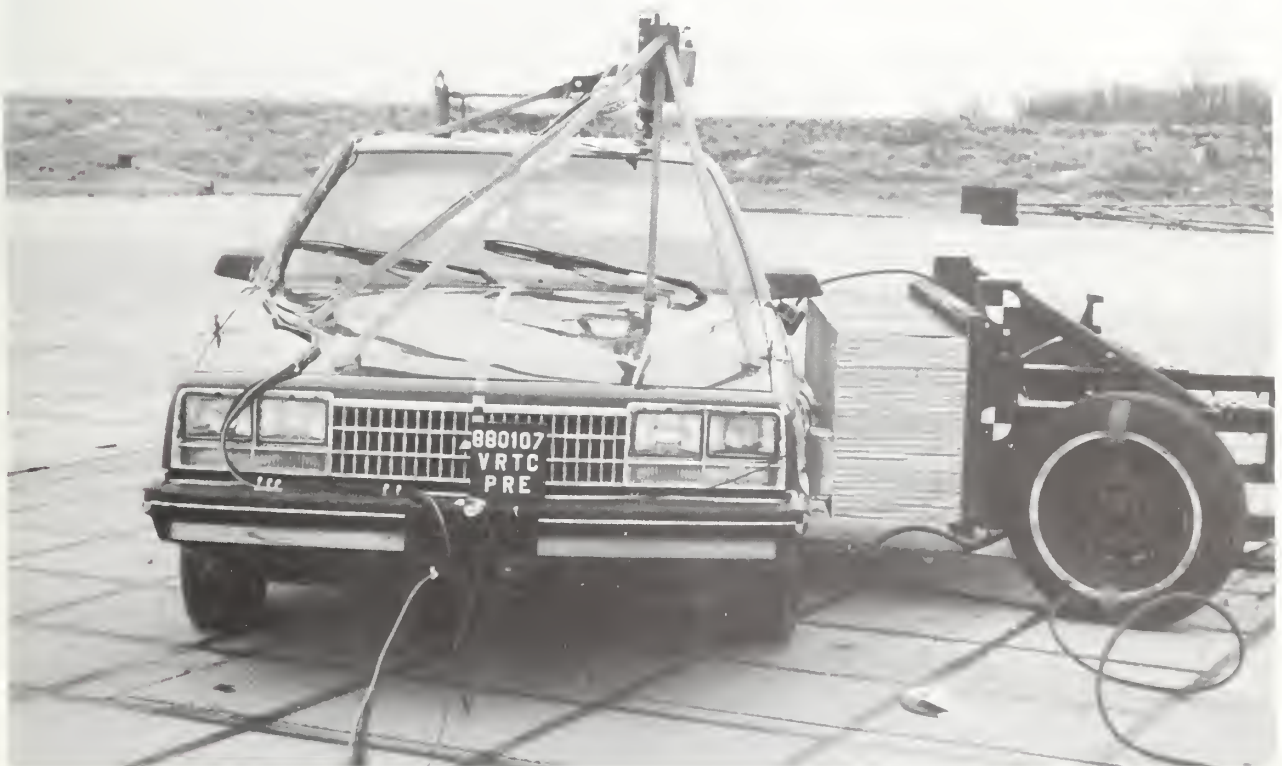


Figure A-4. PRE-TEST FRONT VIEW





Figure A-5. PRE-TEST REAR VIEW

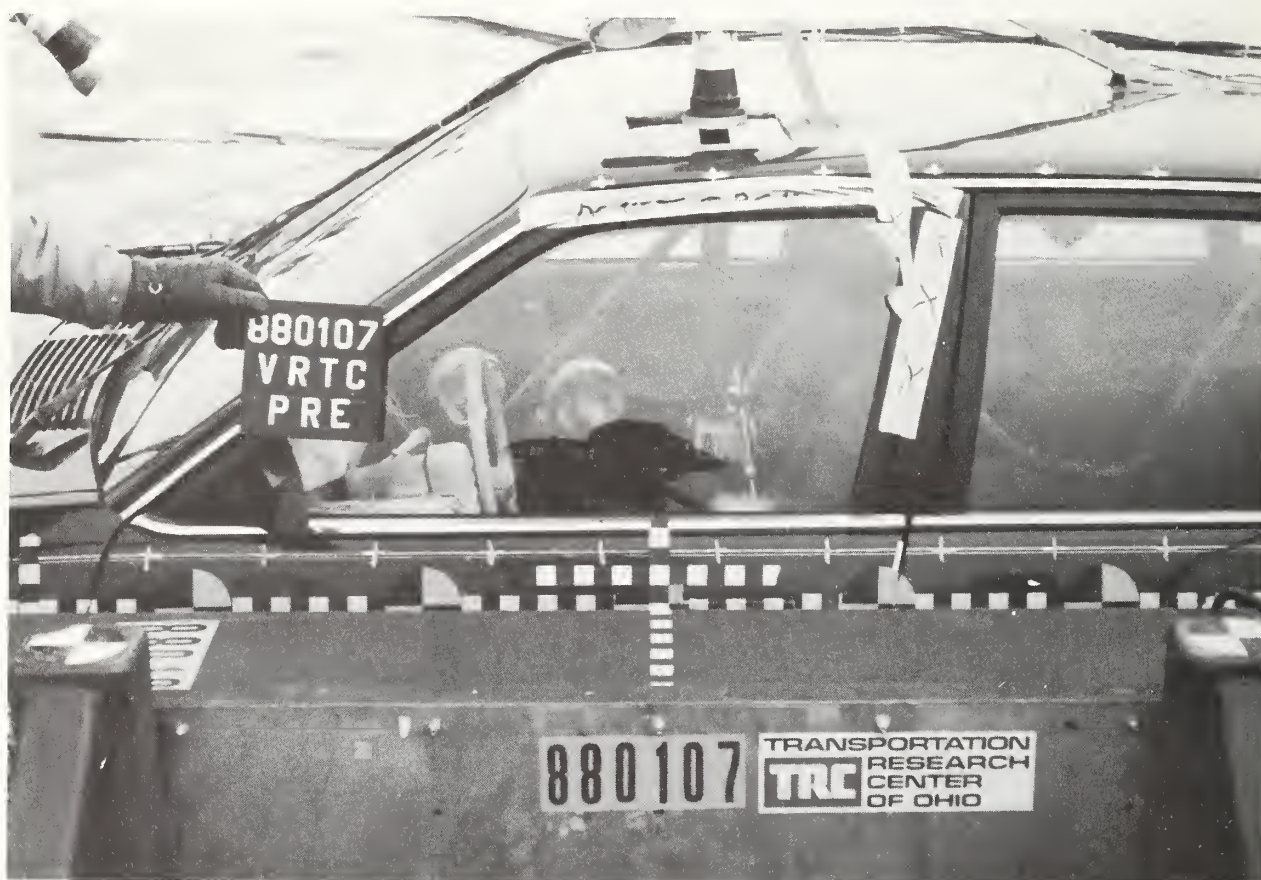


Figure A-6. PRE-TEST ALIGNMENT VIEW



Figure A-7. PRE-TEST BUMPER ALIGNMENT VIEW



Figure A-8. PRE-TEST FRONT DOOR VIEW





Figure A-9. PRE-TEST REAR DOOR VIEW



Figure A-10. POST-TEST OVERALL VIEW  
A-6





Figure A-11. POST TEST LEFT SIDE VIEW



Figure A-12. POST-TEST RIGHT SIDE VIEW  
A-7



Figure A-13. POST-TEST FRONT VIEW



Figure A-14. POST-TEST REAR VIEW





Figure A-15. POST-TEST DOOR VIEW

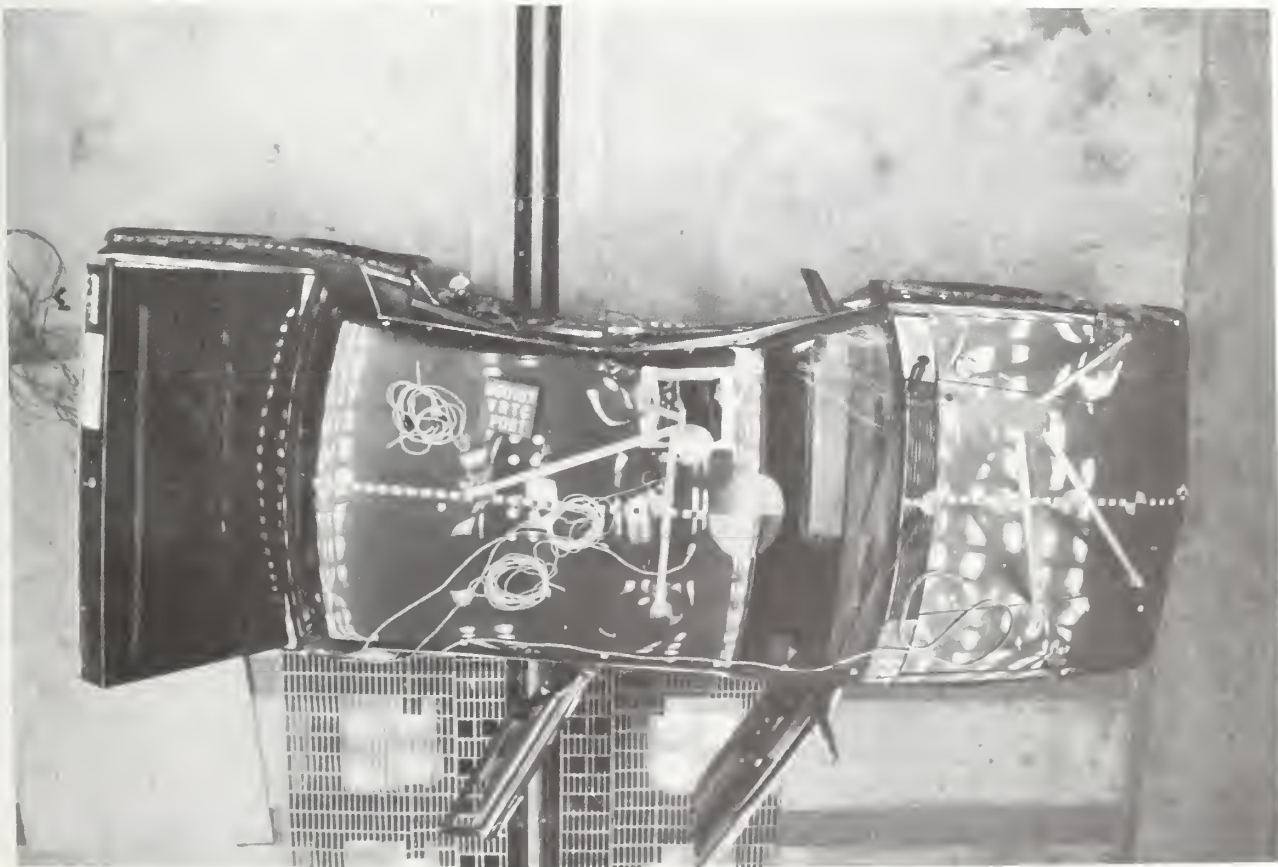


Figure A-16. POST-TEST OVERHEAD VIEW  
A-9



Figure A-17. PRE-TEST MDB FACE - VIEW 1



Figure A-18. PRE-TEST MDB FACE - VIEW 2



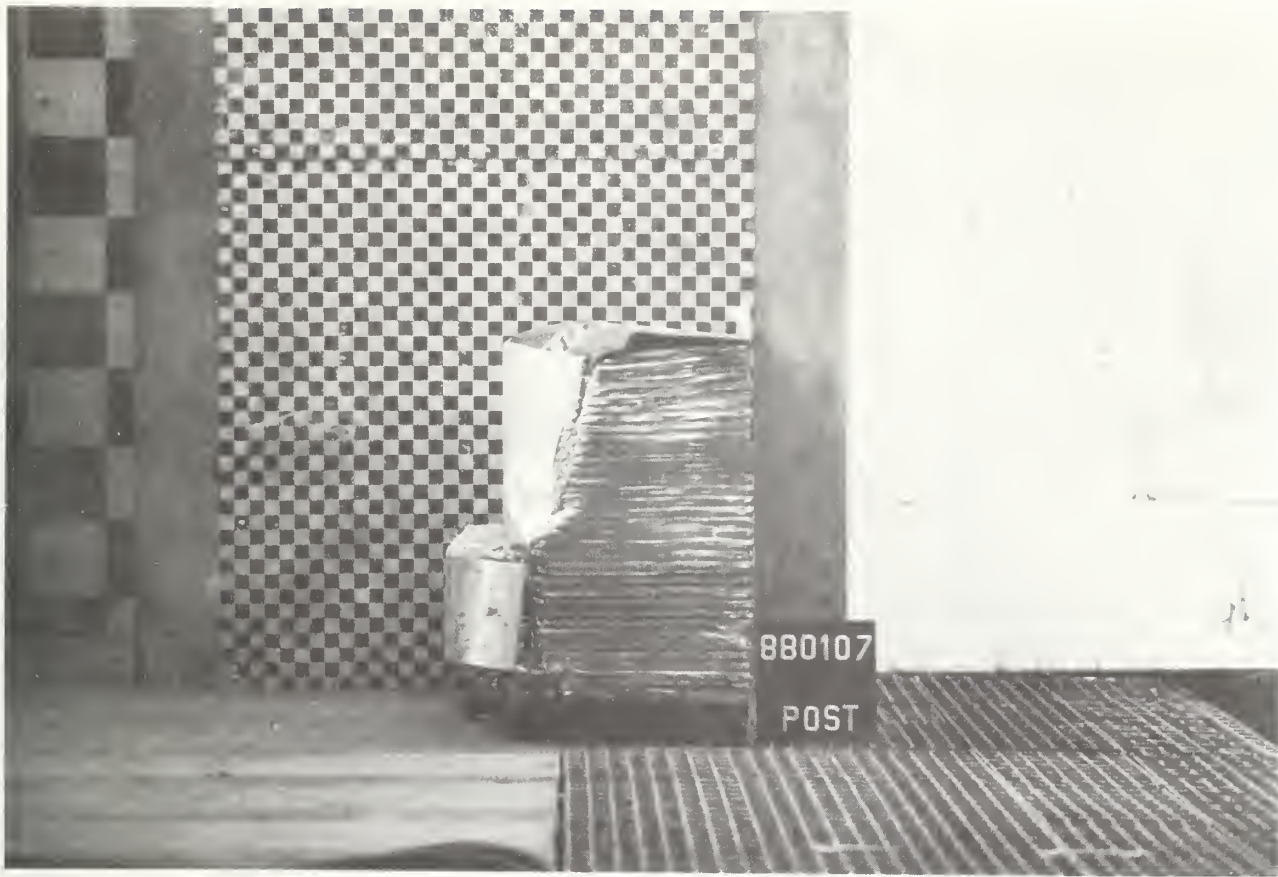


Figure A-19. POST-TEST MDB FACE - VIEW 1

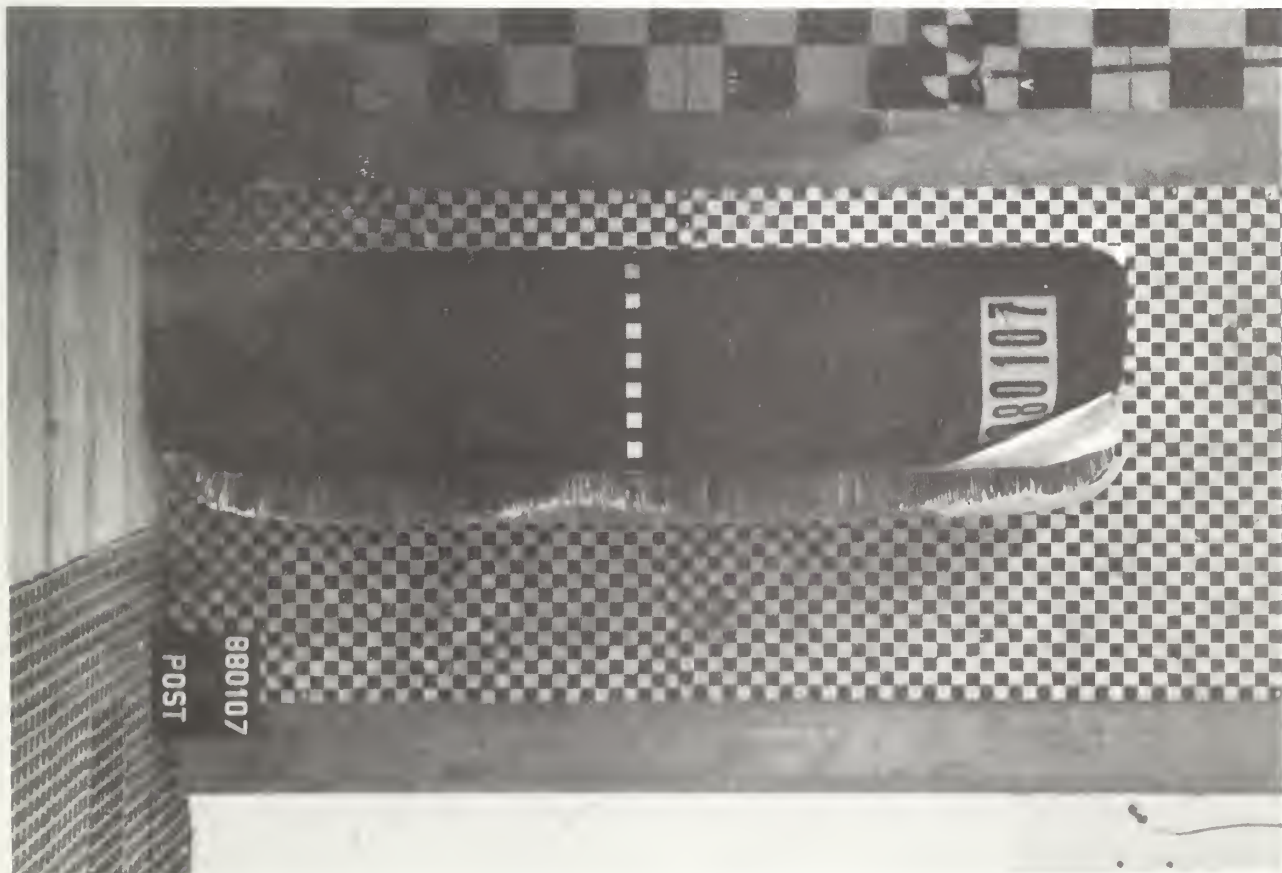


Figure A-20. POST-TEST MDB FACE - VIEW 2

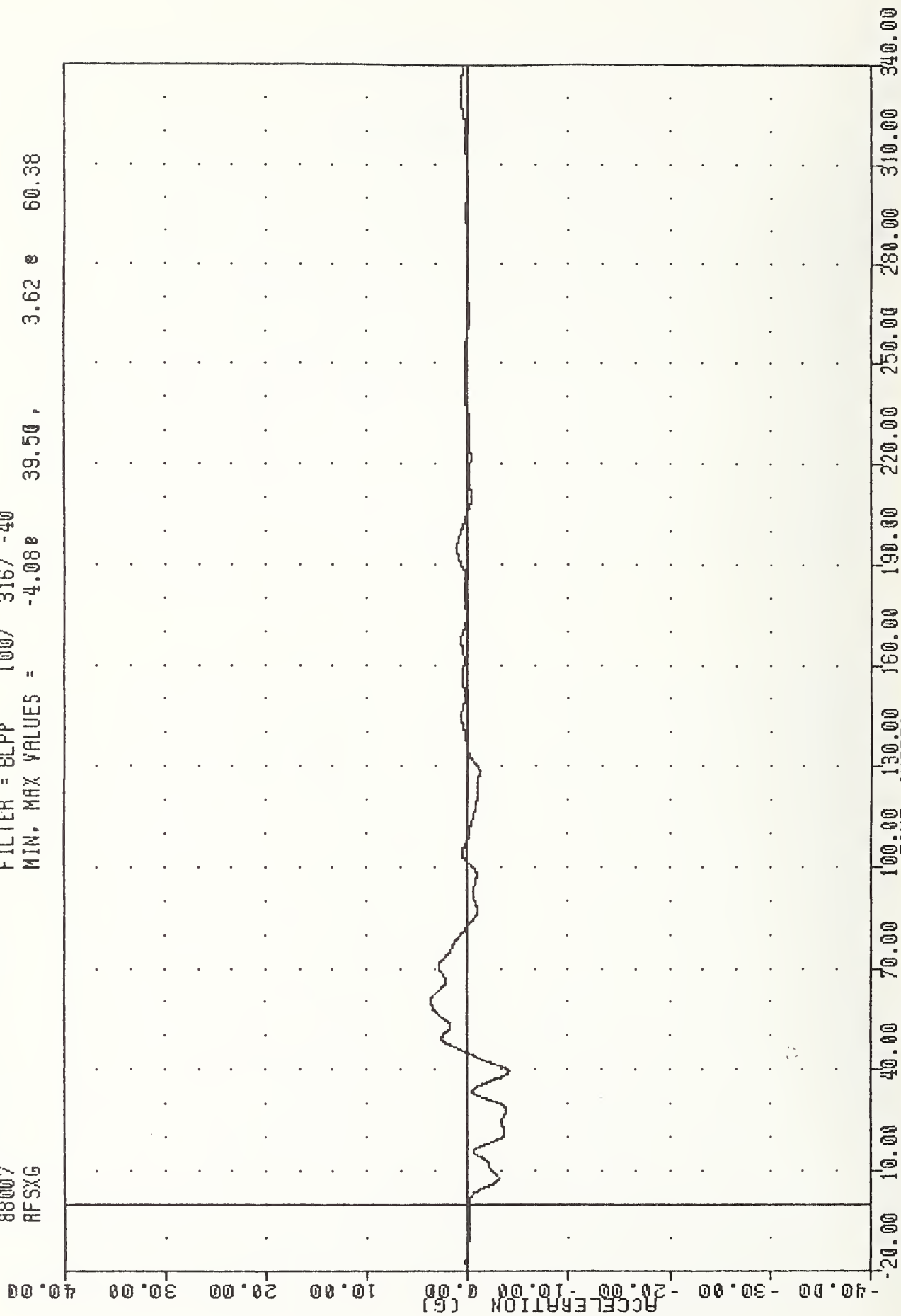


## APPENDIX B

### DATA PLOTS

VRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 88007  
 AFSXG

FILTER = BLPP 100/ 316/ -40  
 MIN. MAX VALUES = -4.08 39.50 , 3.62 60.38

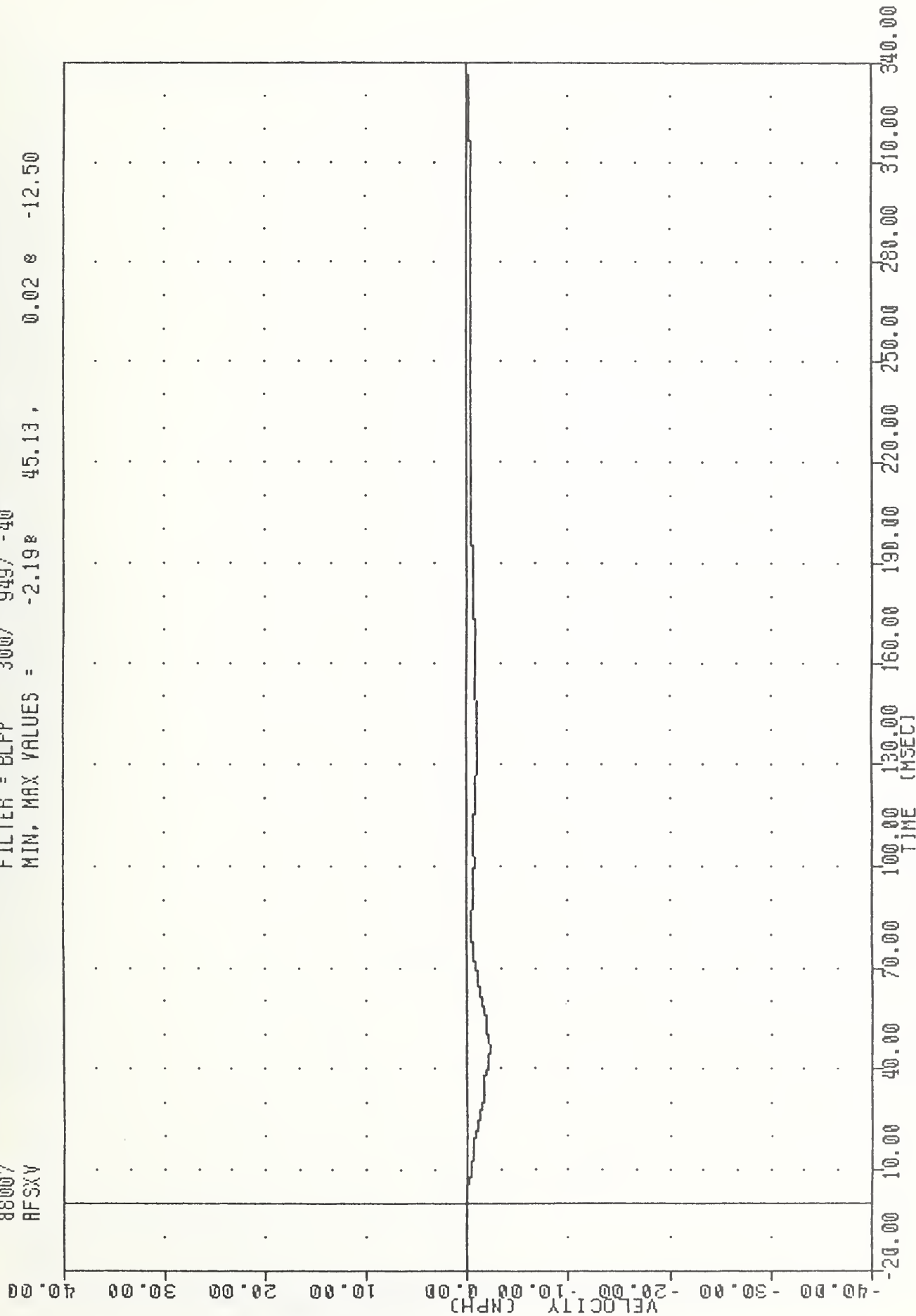


MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 VEHICLE RIGHT FRONT SILL X AXIS ACCELERATION



VRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 88007  
 RFSXV

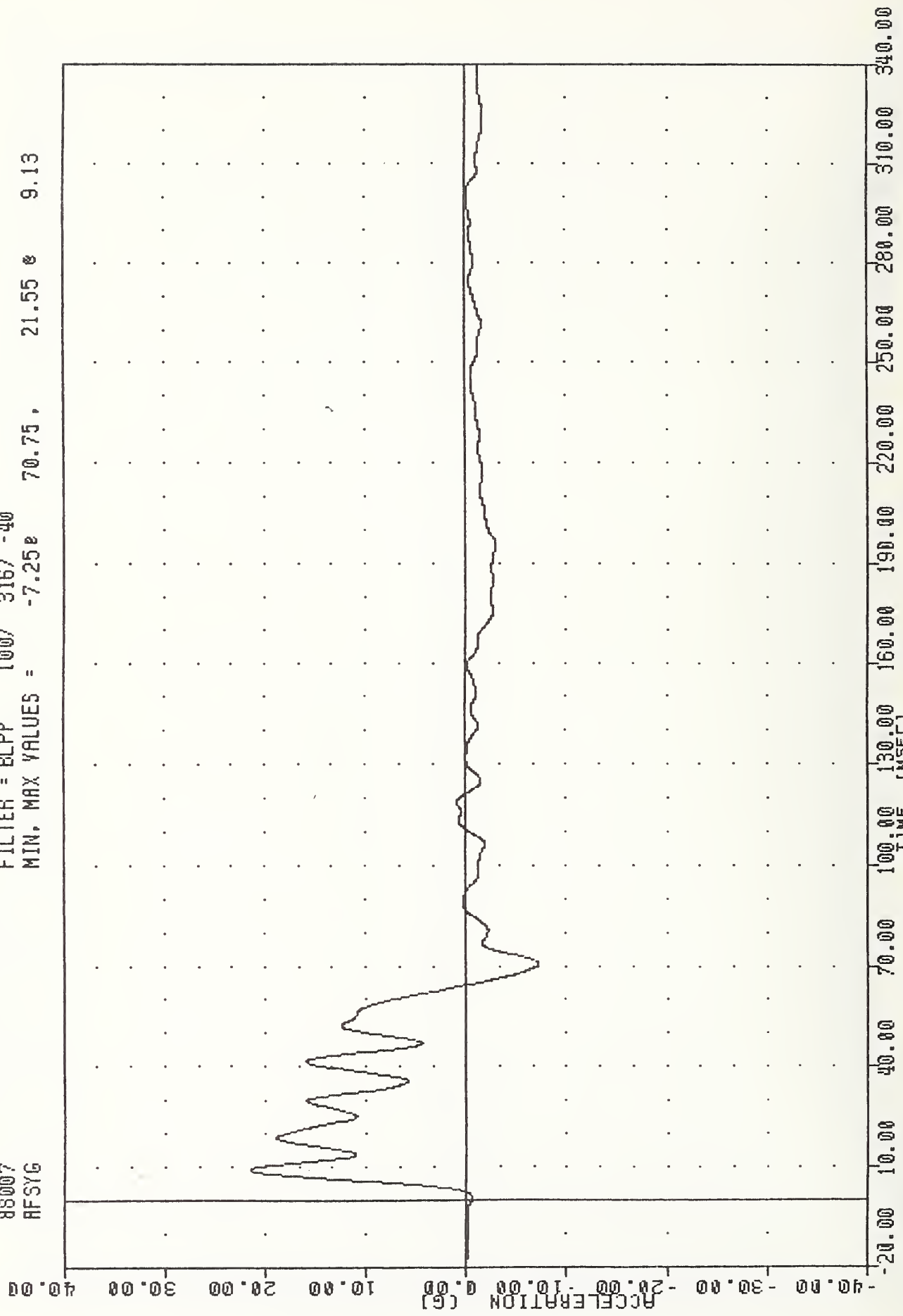
FILTER = BLPP 300/ 949/ -40  
 MIN, MAX VALUES = -2.198 45.13, 0.02 8 -12.50



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 DELTA V USING RFSXG

VRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 88007  
 AFSYG

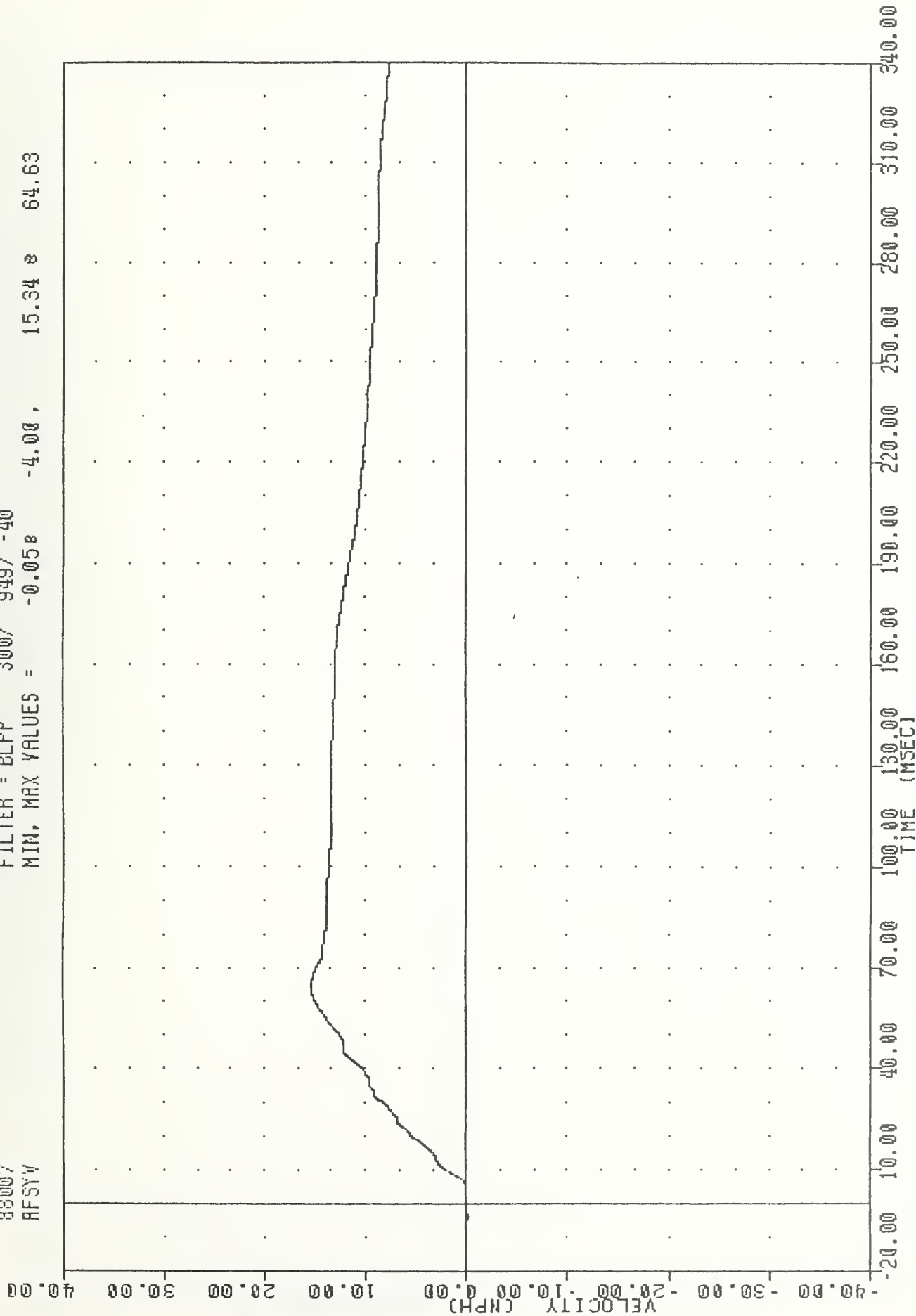
FILTER = BLPP 100/ 316/ -40  
 MIN, MAX VALUES = -7.25e 70.75, 21.55 e 9.13



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 VEHICLE RIGHT FRONT SILL Y AXIS ACCELERATION

WRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 88007  
 RFSYV

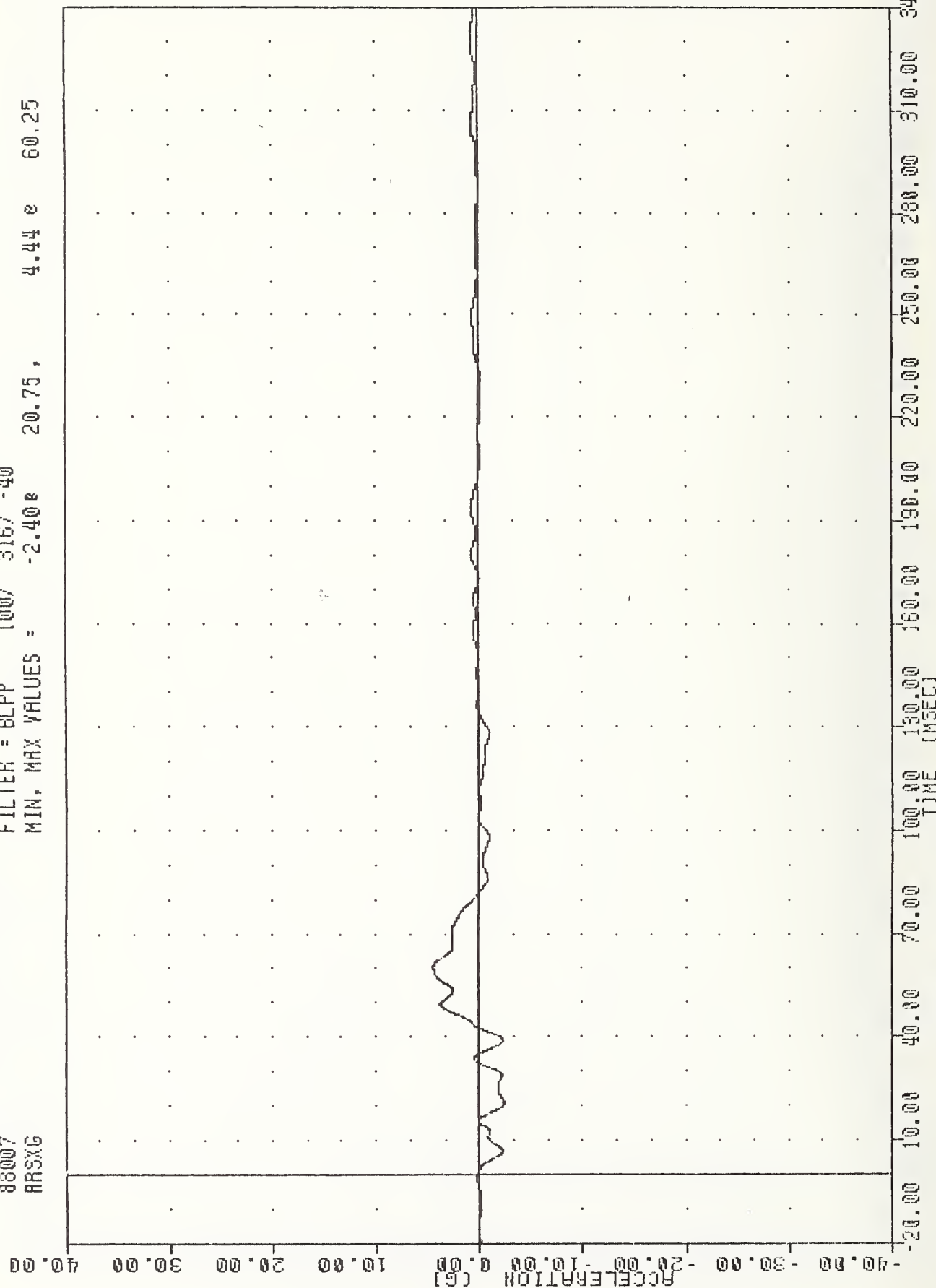
FILTER = BLPP 300/ 949/ -40  
 MIN. MAX VALUES = -0.058 -4.00 , 15.34 8 64.63



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 DELTA V USING RFSYG

VRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 88007  
 ARSXC

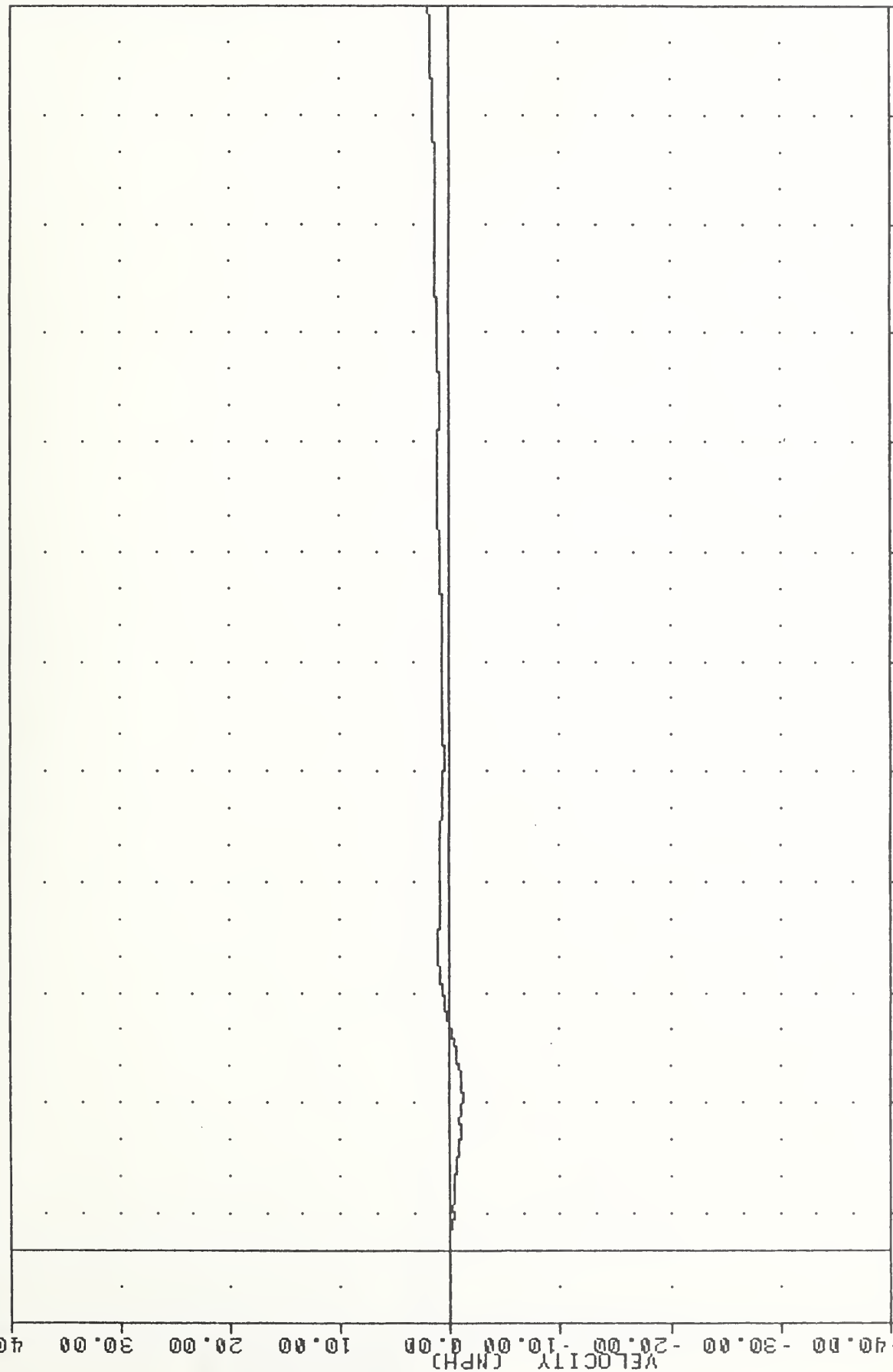
FILTER = BLPP 100/ 316/ -40  
 MIN, MAX VALUES = -2.40e 20.75, 4.44 e 60.25



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 VEHICLE RIGHT REAR SILL X AXIS ACCELERATION

VRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 88007  
 ARSXV

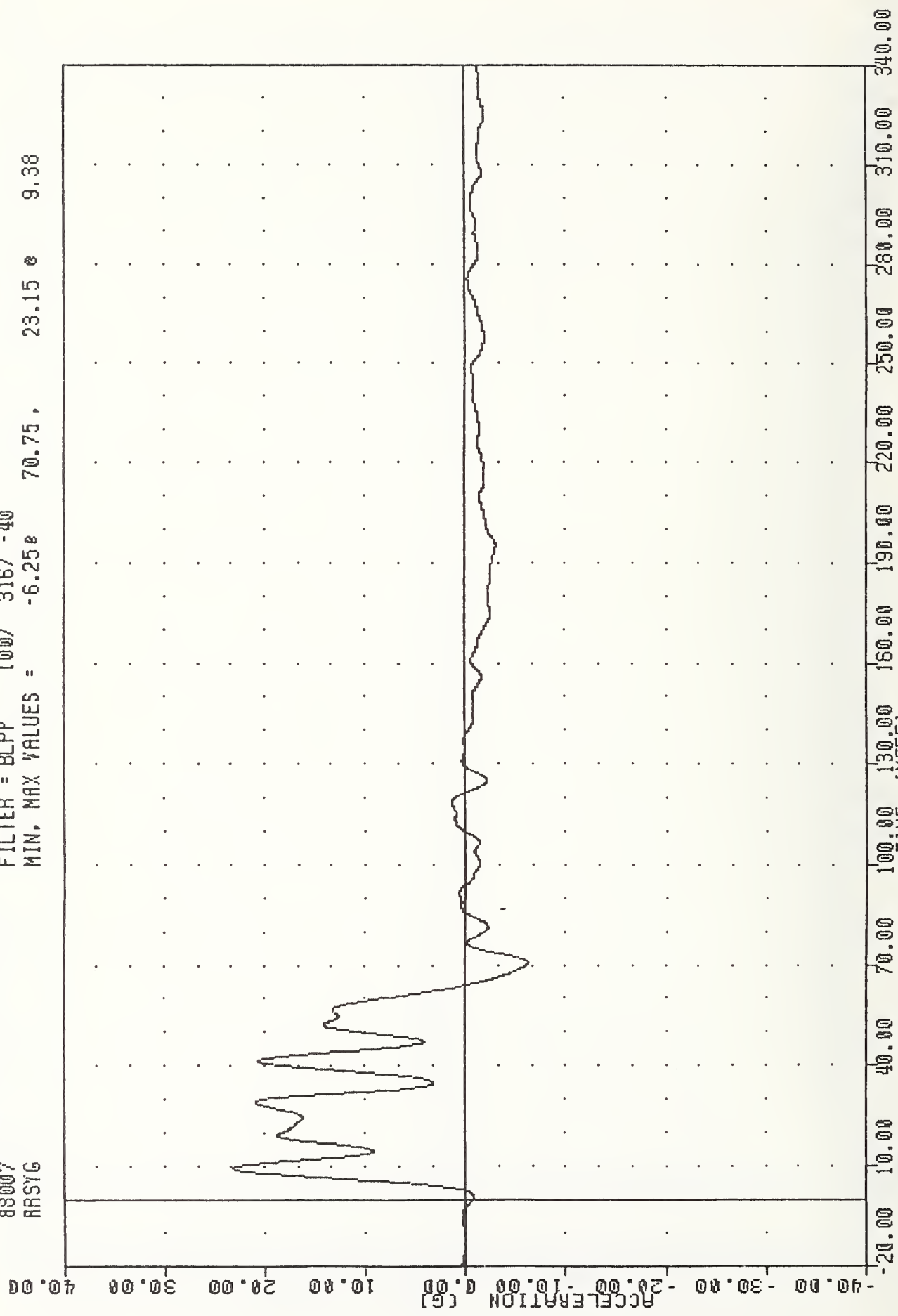
FILTER = BLPP 300/ 949/ -40  
 MIN. MAX VALUES = -1.19e 41.38 , 1.88 e 340.00



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 DELTA V USING ARSXG

VRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 88007  
 ARSYG

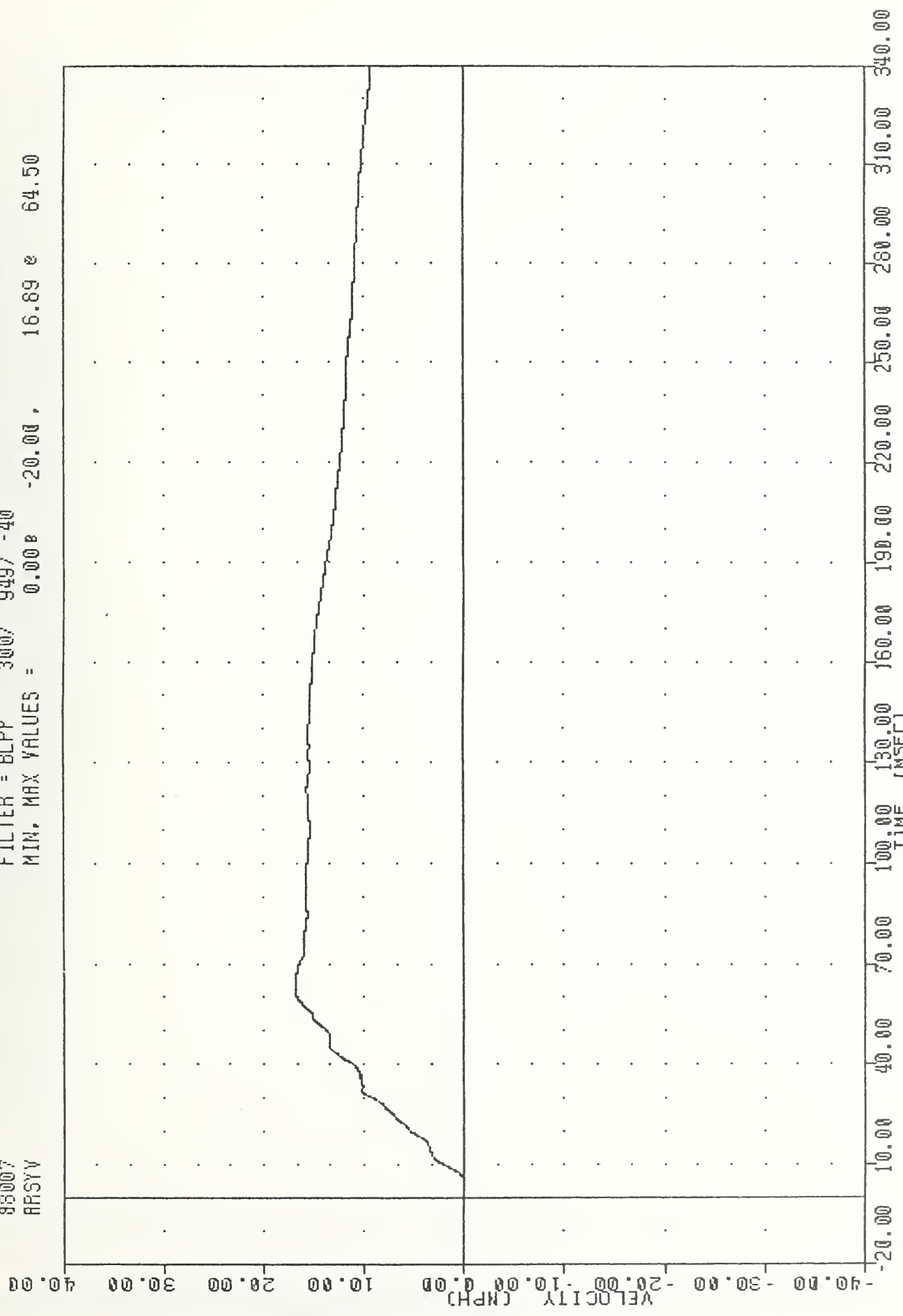
FILTER = BLPP 100/ 316/ -40  
 MIN, MAX VALUES = -6.25e 70.75, 23.15 e 9.38



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 VEHICLE RIGHT REAR SILL Y AXIS ACCELERATION

VRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 88007  
 ARSYV

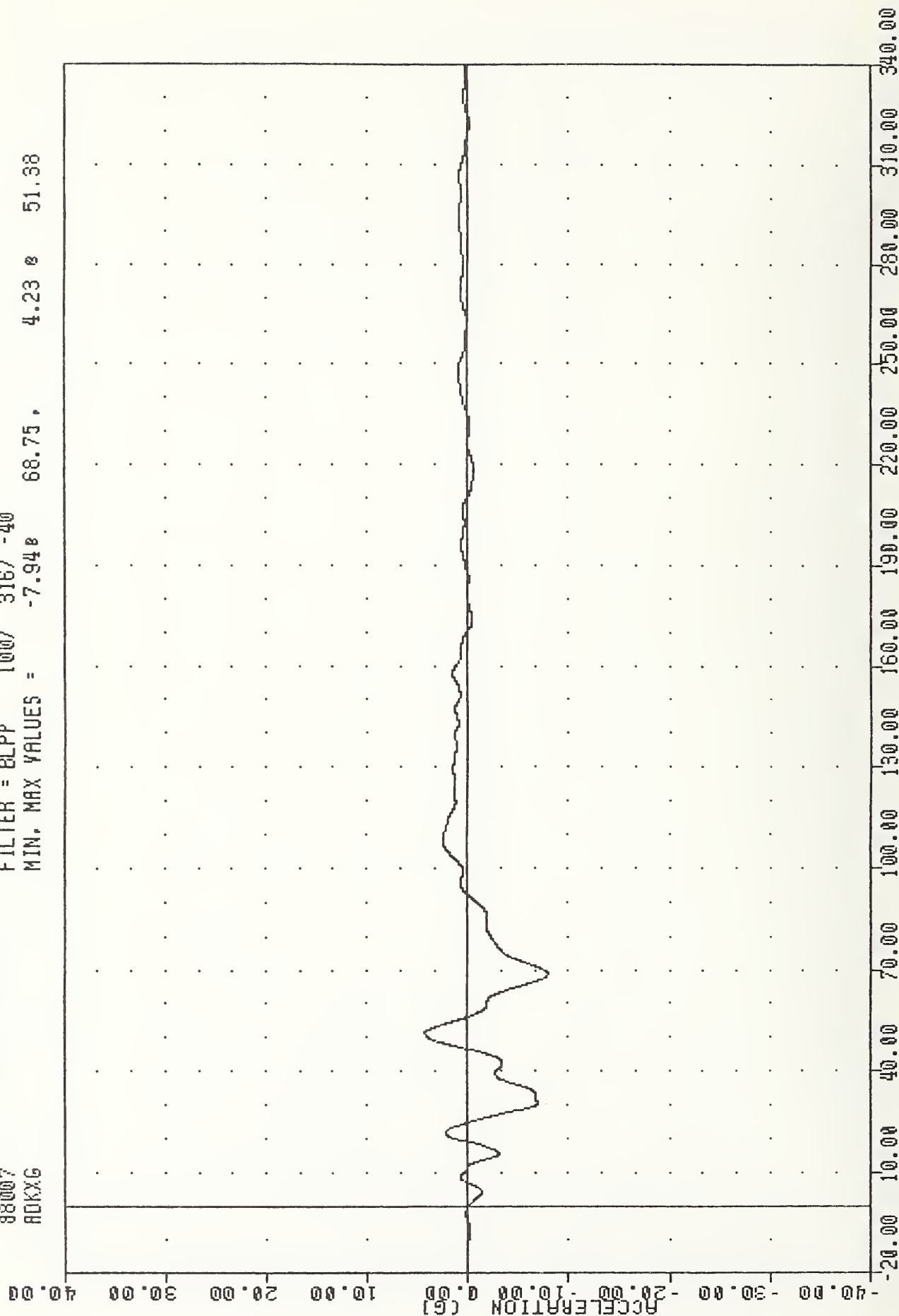
FILTER = BLPP 300/ 949/ -40  
 MIN, MAX VALUES = 0.008 -20.00 , 16.89 e 64.50



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 DELTA V USING ARSYG

VRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 880007  
 ADKXG

FILTER = BLPP 100/ 316/ -40  
 MIN. MAX VALUES = -7.94g 68.75g 4.23g 51.38

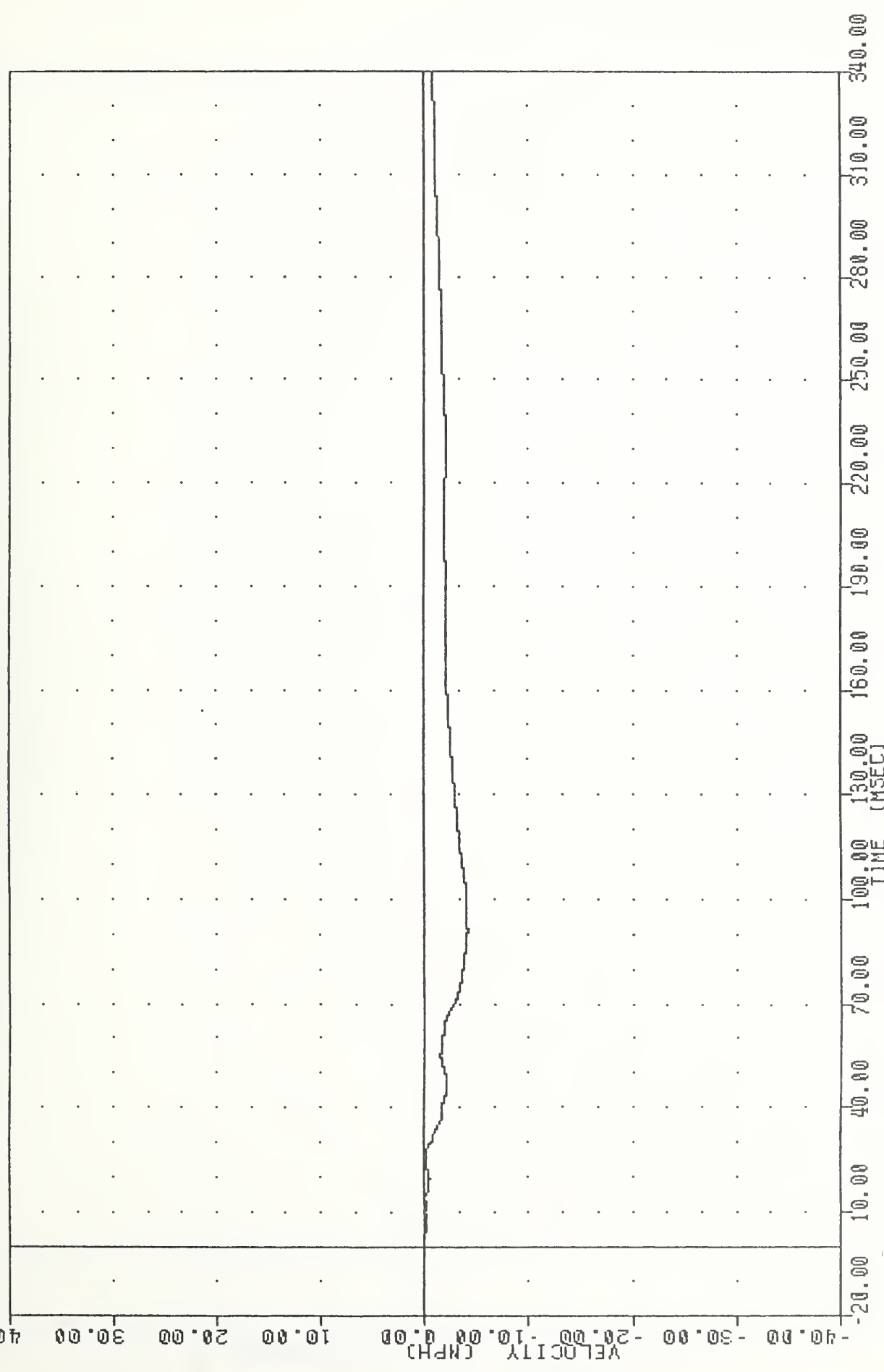


MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 VEHICLE REAR DECK X AXIS ACCELERATION



WRTC , 880107  
SI PROTECTION PROD VEHICLE  
88007  
ADKXV

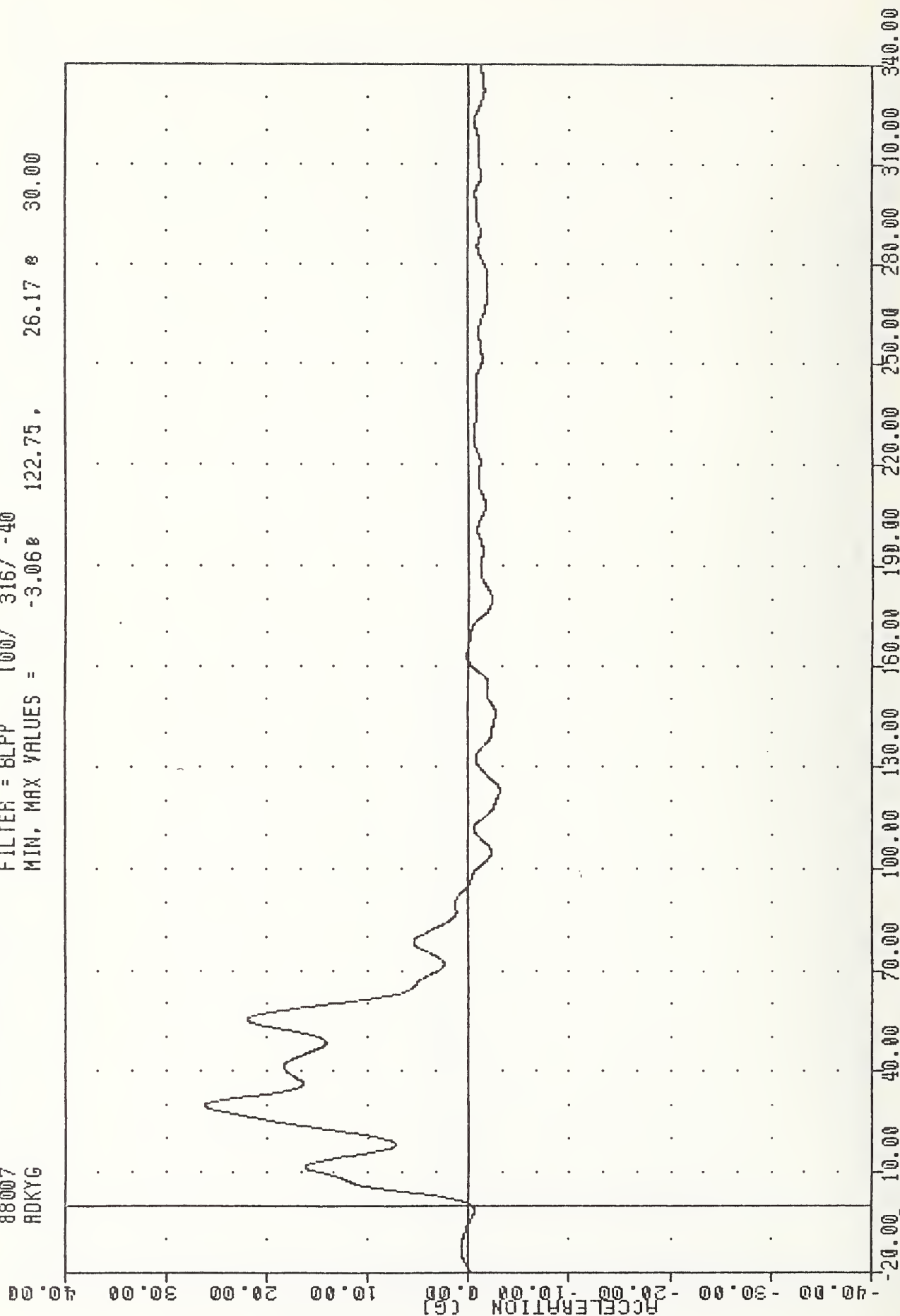
FILTER = BLPP 300/ 949/ -40  
MIN, MAX VALUES = -4.09% 90.88, 0.01 % 13.88



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
DELTA V USING ADKXG

VRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 88007  
 ADKYG

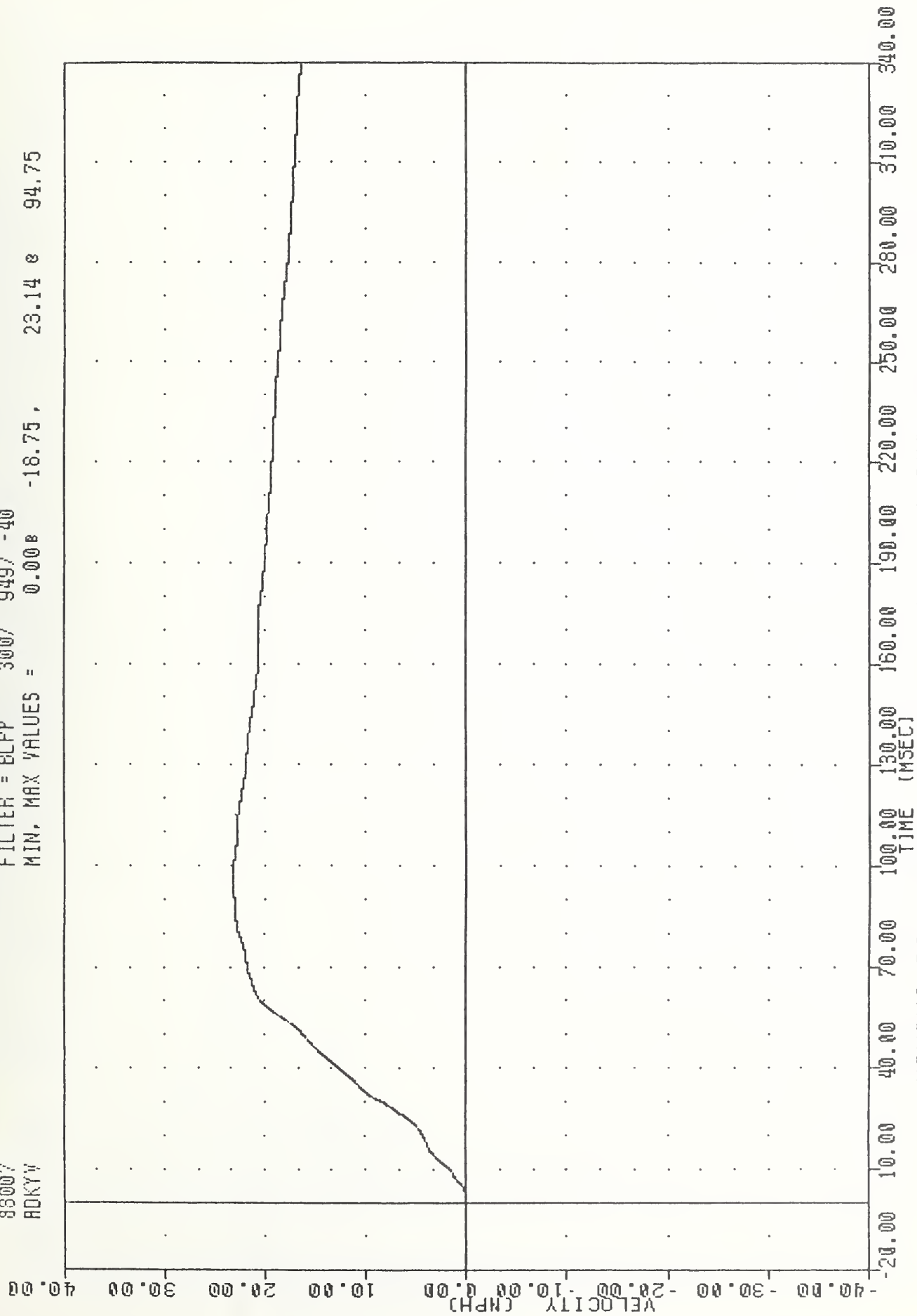
FILTER = BLPP 100/ 316/ -40  
 MIN. MAX VALUES = -3.068 122.75 26.17 30.00



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 VEHICLE REAR DECK Y AXIS ACCELERATION

VRTC  
SI PROTECTION PROD VEHICLE  
88007  
RDYV

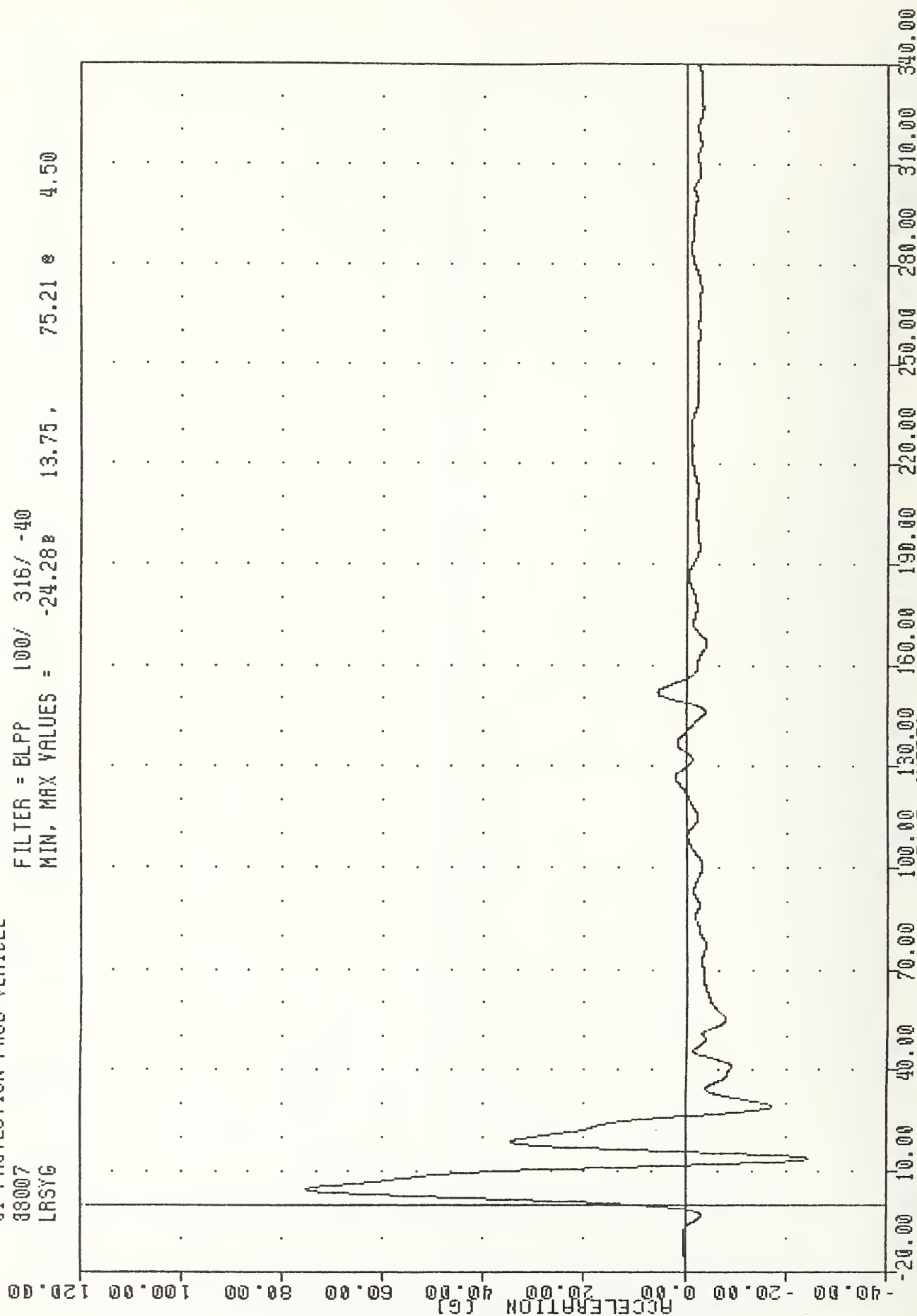
FILTER = BLFP 300/ 949/ -40  
MIN. MAX VALUES = 0.00 23.14 8 94.75  
-18.75,



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
DELTA V USING RDKYG

YRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 88007  
 LRSYG

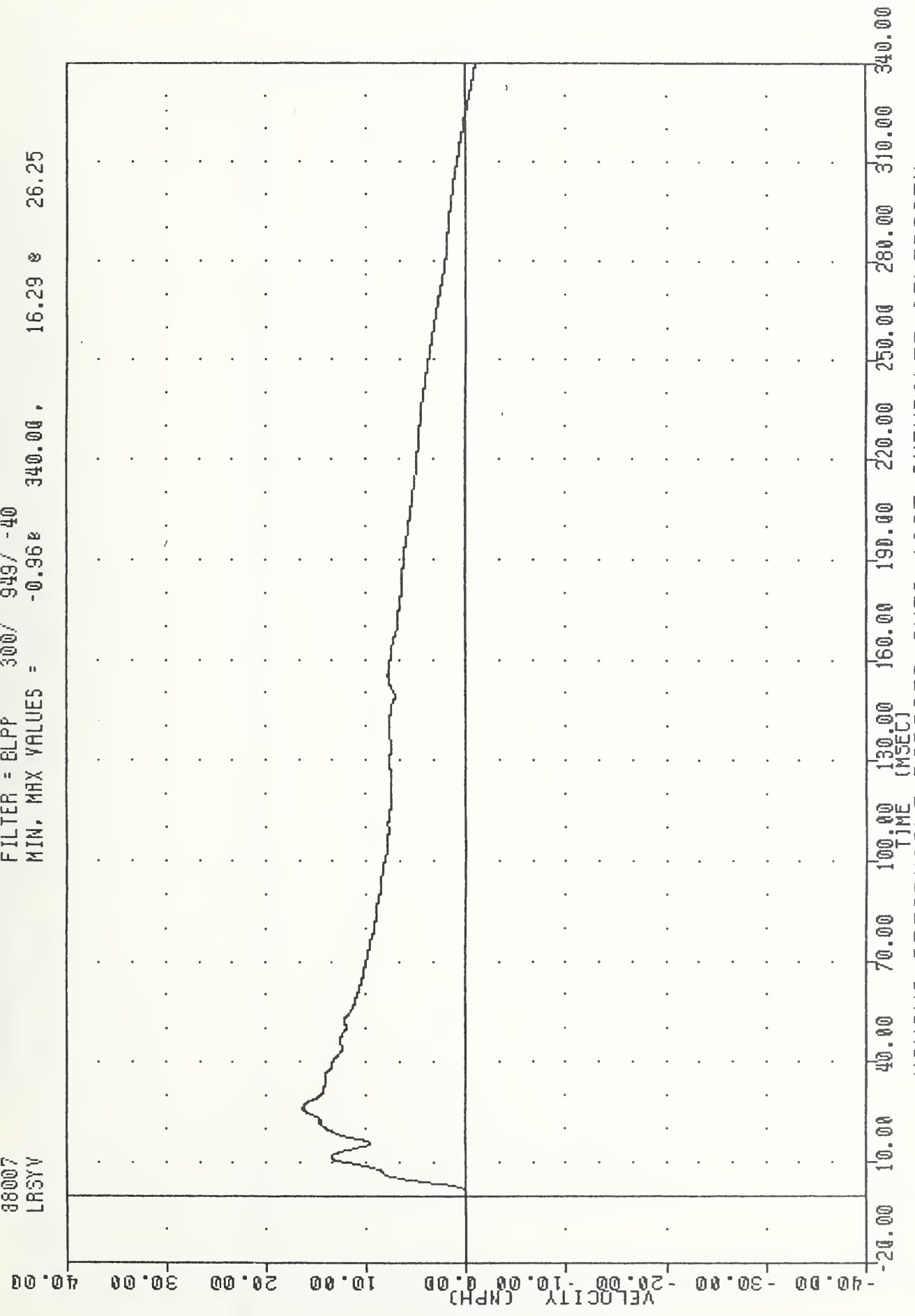
FILTER = BLPP 100/ 316/ -40  
 MIN, MAX VALUES = -24.28 13.75 , 75.21 4.50



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 VEHICLE LEFT REAR SILL Y AXIS ACCELERATION

VRTC , 880107  
SI PROTECTION PROD VEHICLE  
88007  
LRSYV

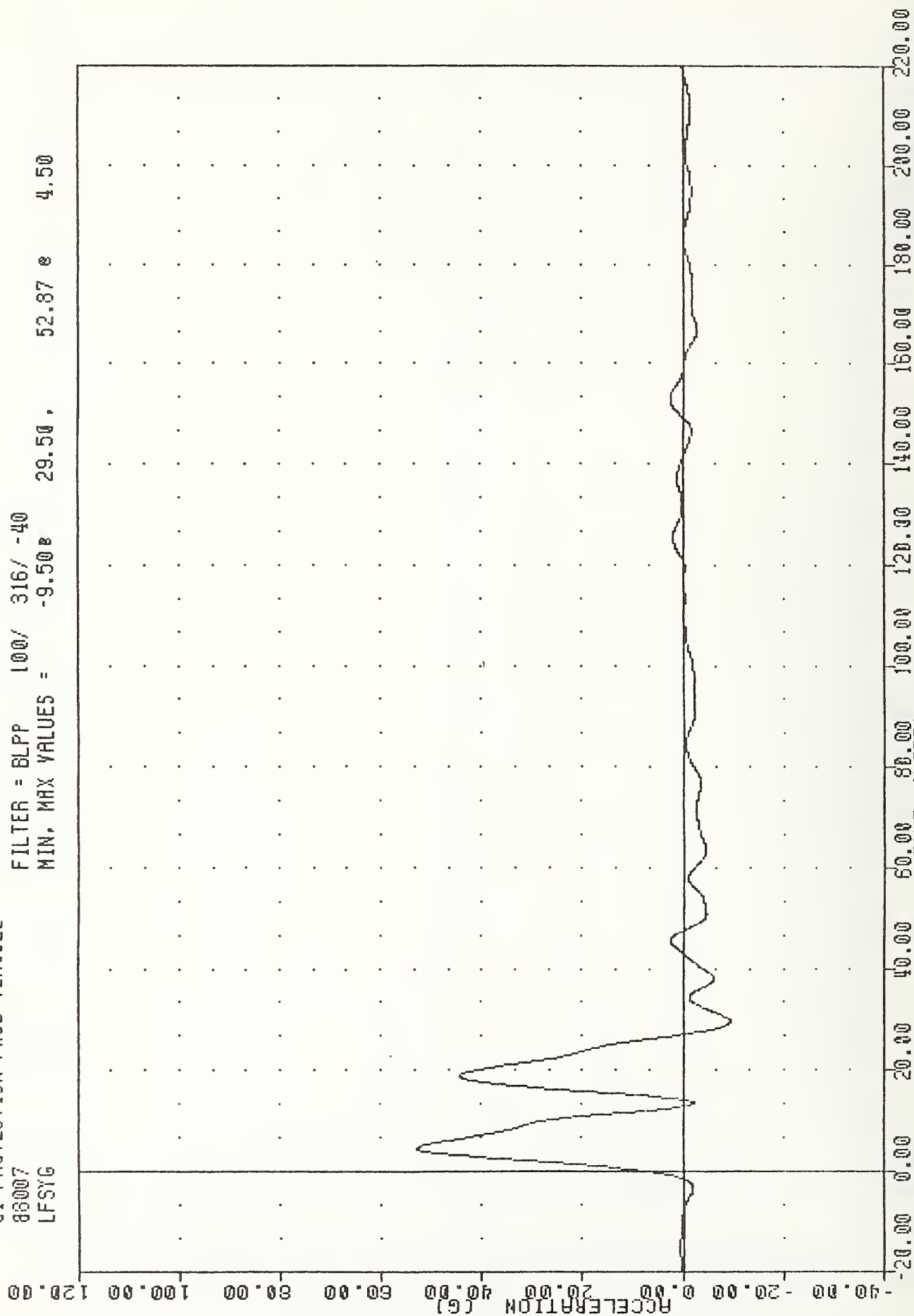
FILTER = BLPP 300/ 949/ -40  
MIN, MAX VALUES = -0.96 340.00, 16.29 26.25



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
DELTA V USING LRSYG

VRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 880007  
 LFSYG

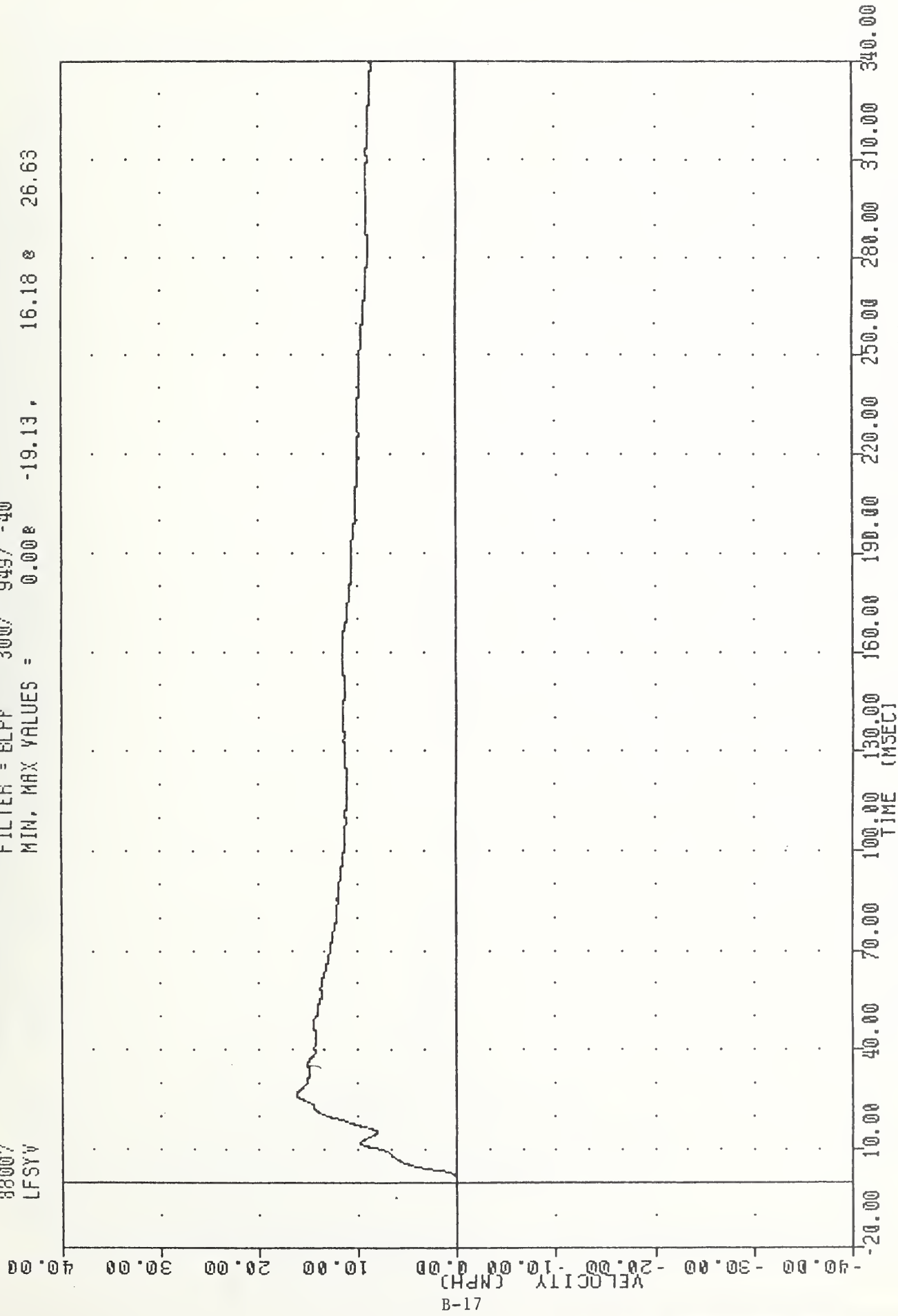
FILTER = BLPP 100/ 316/ -40  
 MIN, MAX VALUES = -9.50 29.50 52.87 4.50



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 VEHICLE LEFT FRONT SILL Y AXIS ACCELERATION

VRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 88007  
 LFSYV

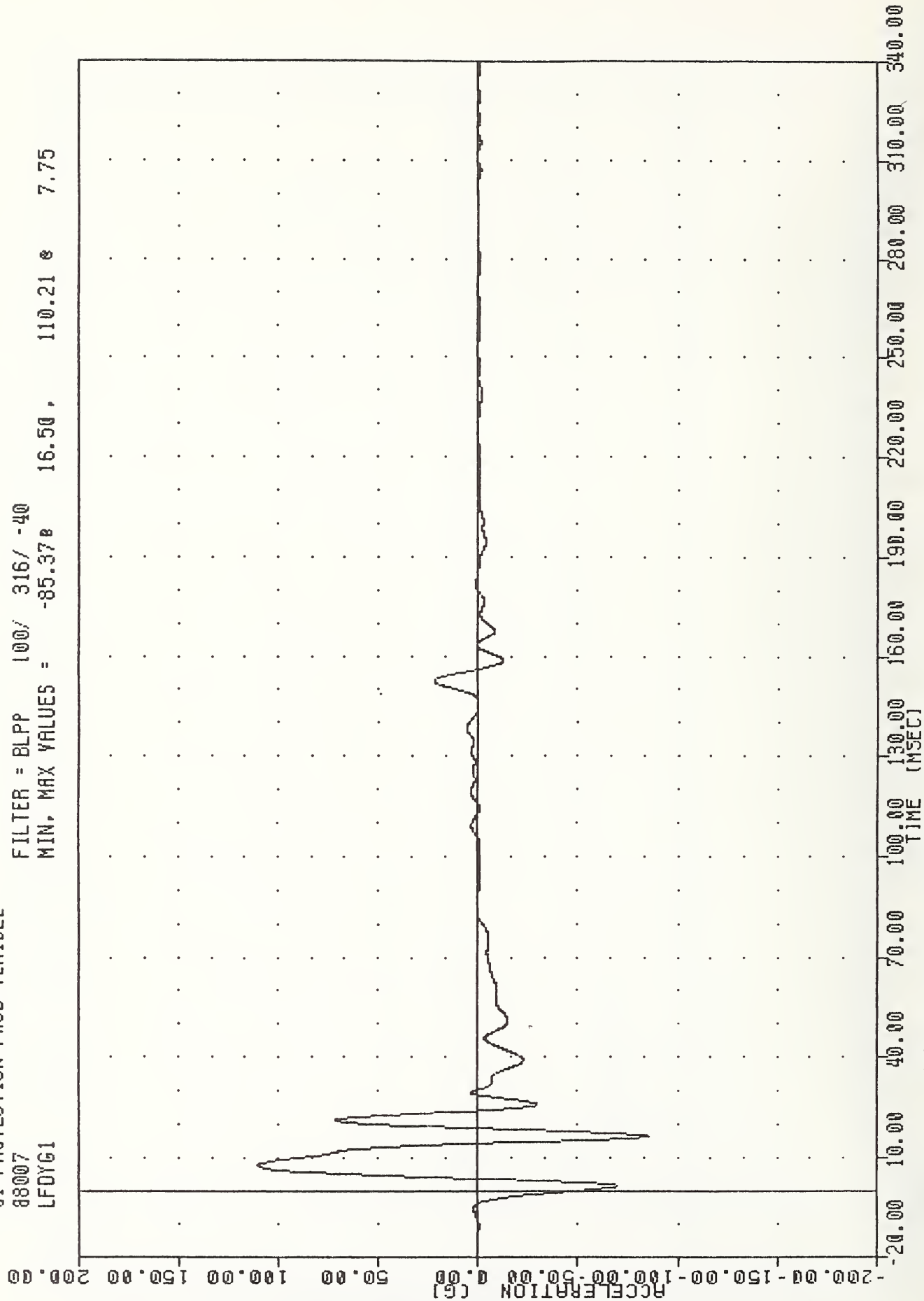
FILTER = BLPP 300/ 949/ -40  
 MIN. MAX VALUES = 0.00 16.18 26.63  
 -19.13 ,



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 DELTA V USING LFSYG

VRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 88007  
 LFDY61

FILTER = BLPP 100/ 316/ -40  
 MIN, MAX VALUES = -85.37 16.50, 110.21 7.75

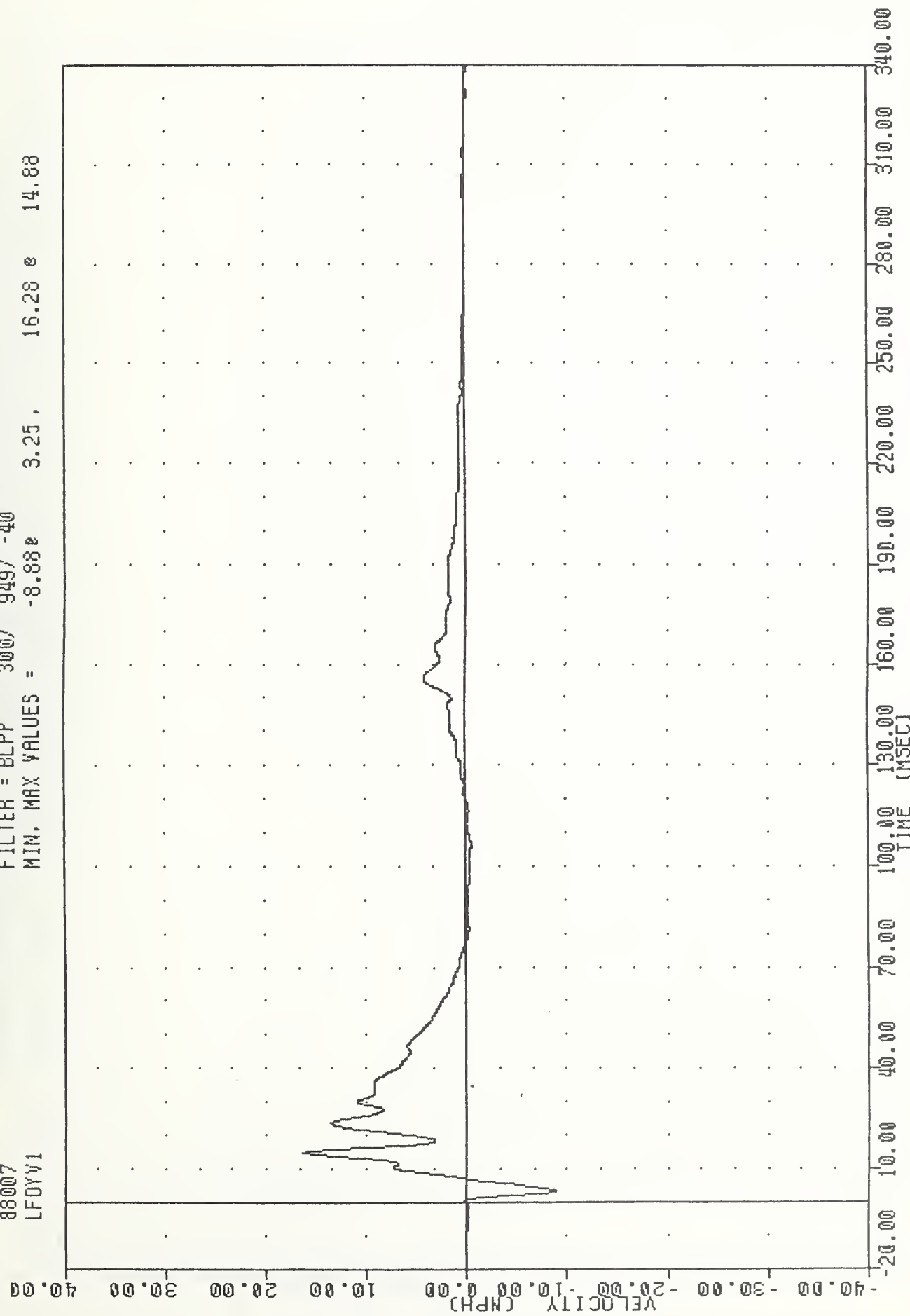


MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 VEHICLE LEFT FRONT DOOR (POSITION 6) Y AXIS ACCELERATION



VRTC, 880107  
SI PROTECTION PROD VEHICLE  
88007  
LFDV V1

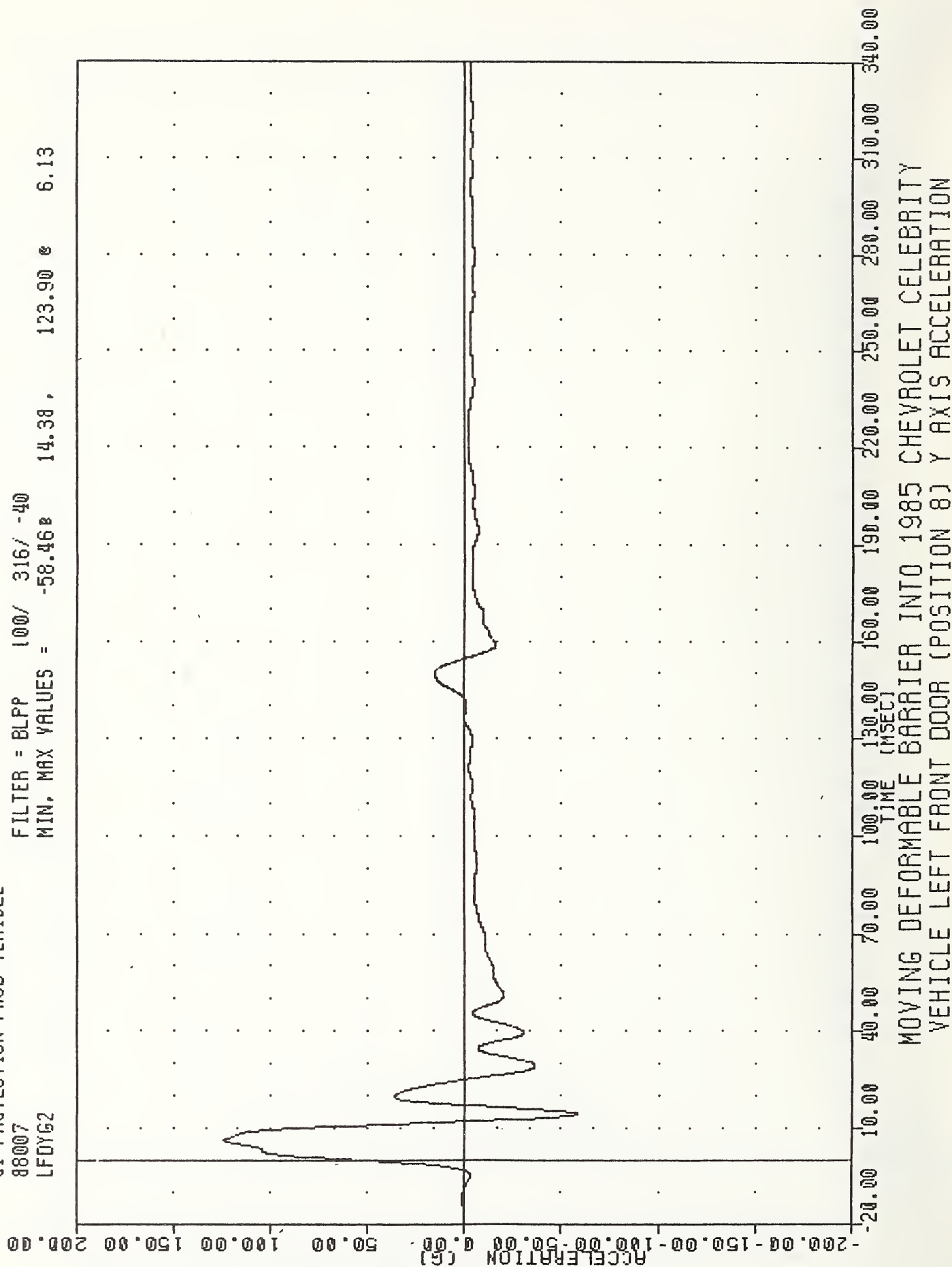
FILTER = BLPP 300/ 949/ -40  
MIN. MAX VALUES = -8.88 16.28 14.88



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
DELTA V USING LFDYGI

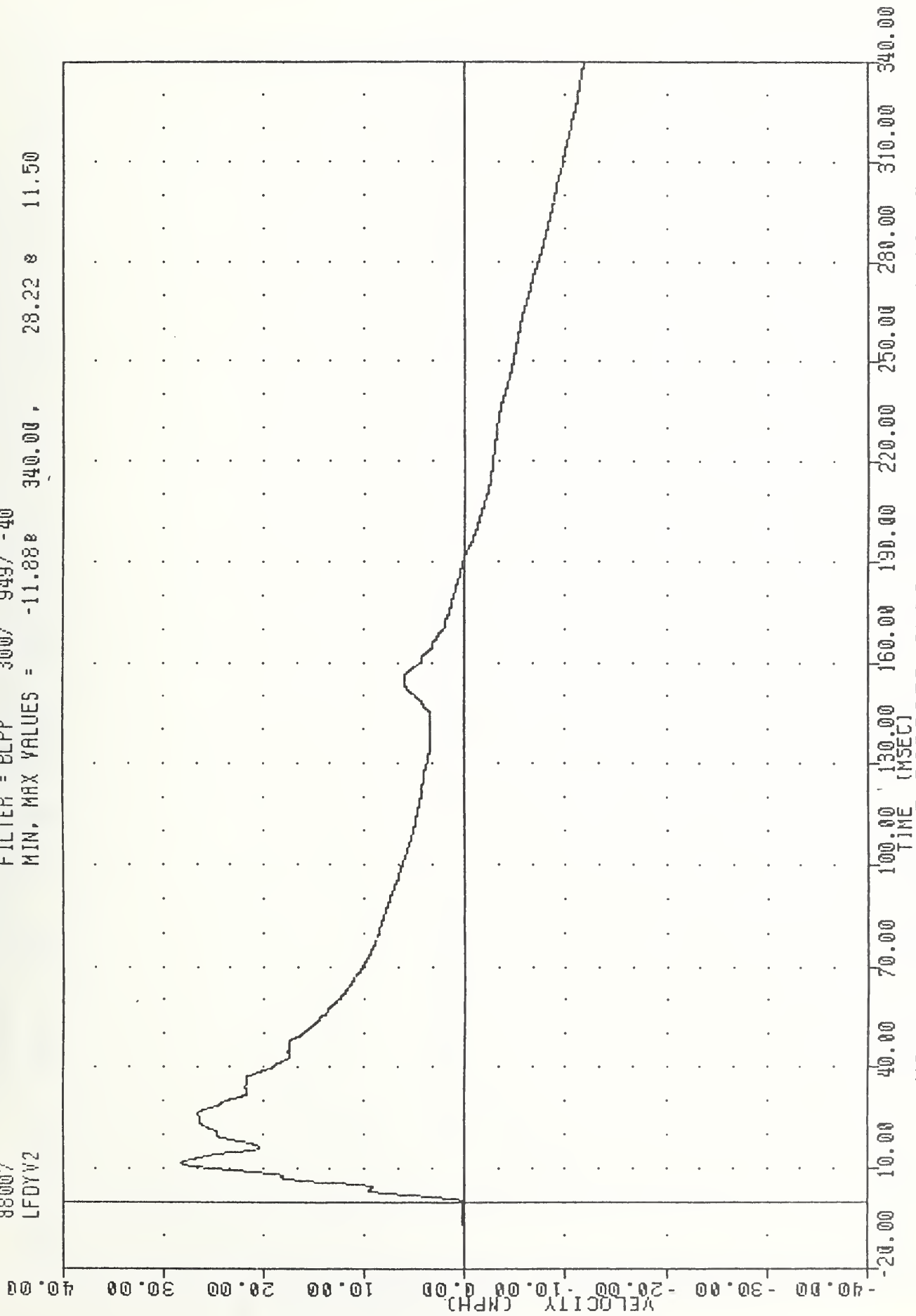
VRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 88007  
 LFDY62

FILTER = BLPP 100/ 316/ -40  
 MIN, MAX VALUES = -58.46 14.38 , 123.90 6.13



VRTC , 880107  
SI PROTECTION PROD VEHICLE  
88007  
LFDYV2

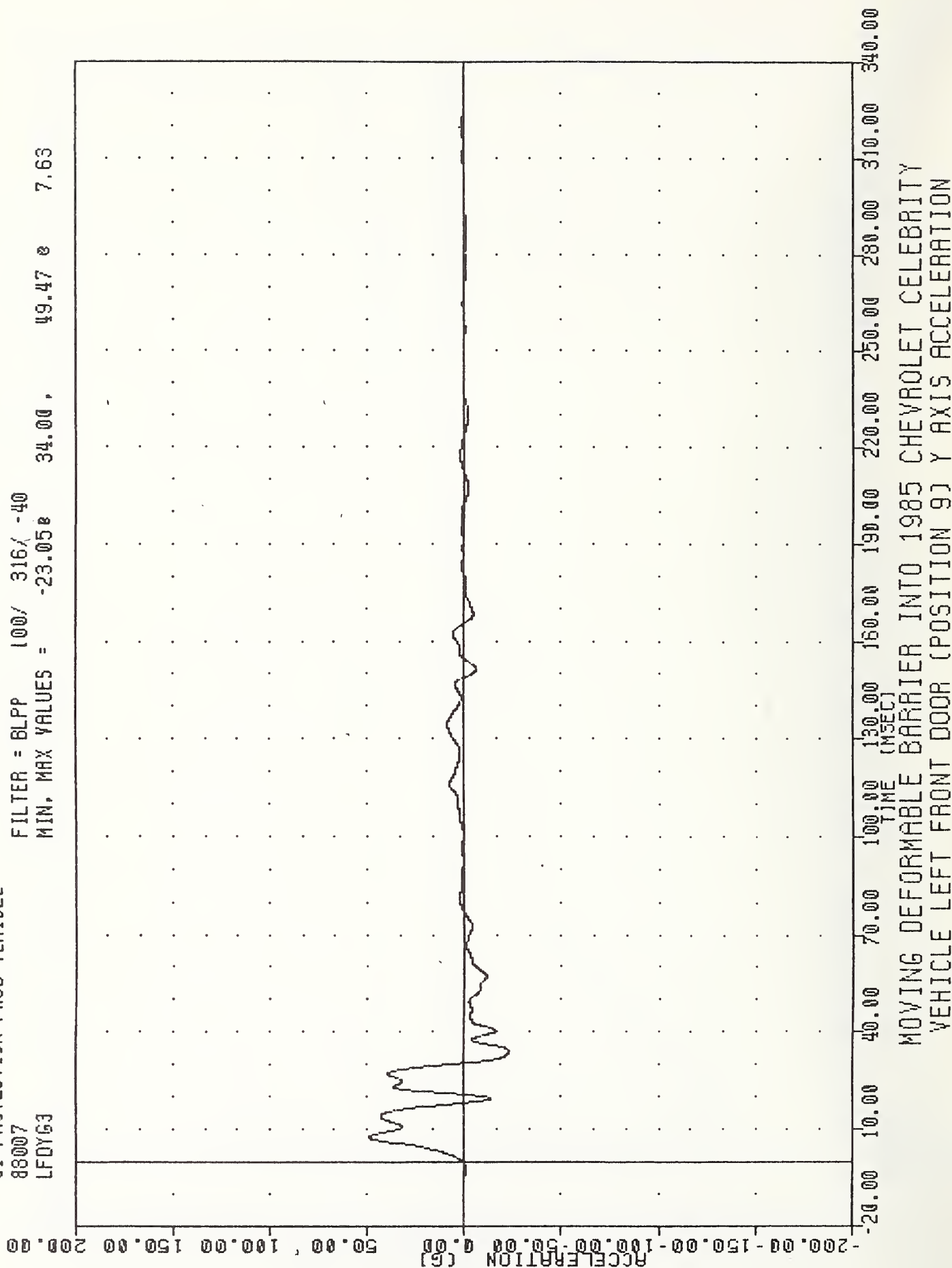
FILTER = BLPP 300/ 949/ -40  
MIN, MAX VALUES = -11.88e 340.00, 28.22 e 11.50



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
DELTA V USING LFDYV2

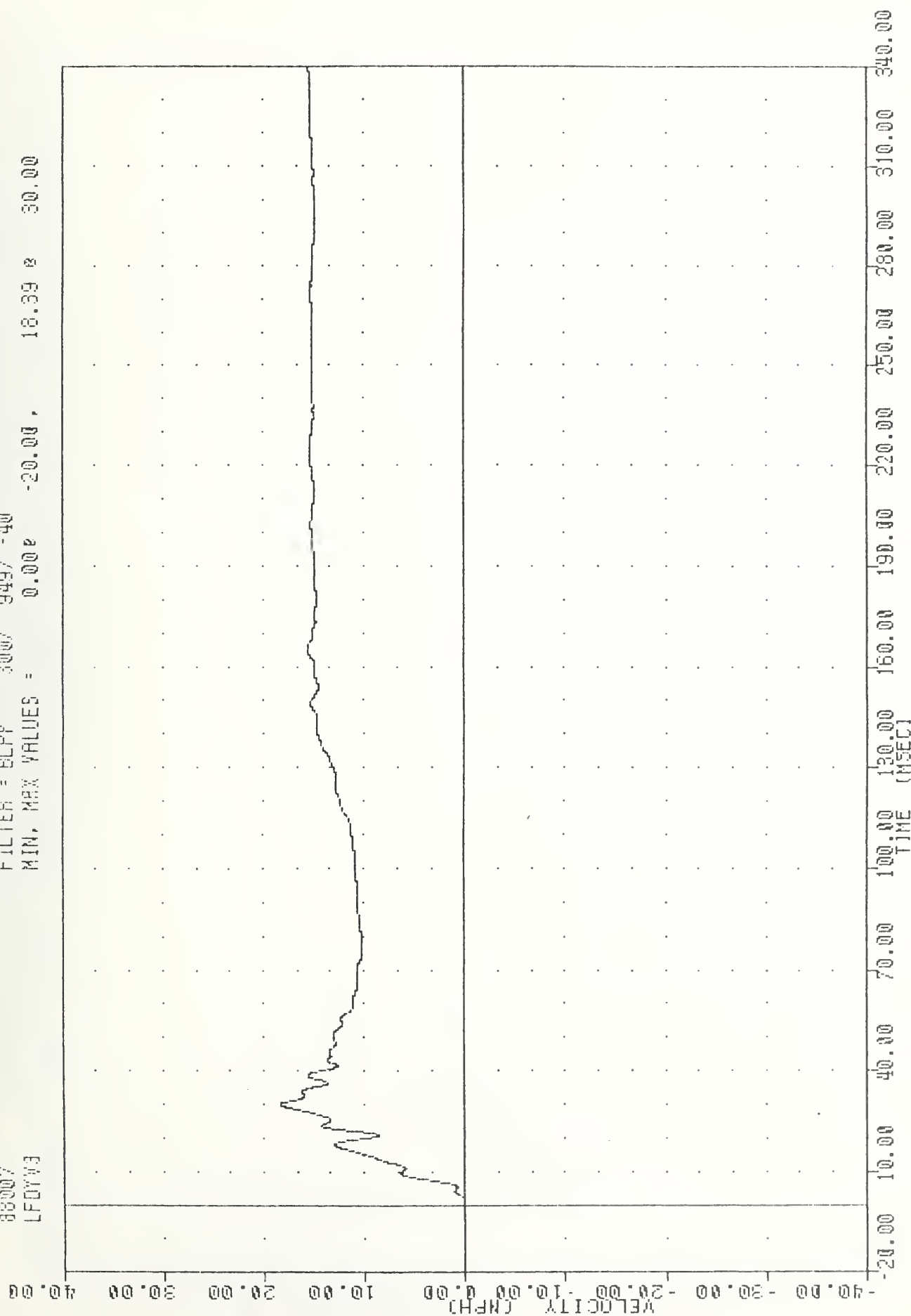
VRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 88007  
 LFDY63

FILTER = BLPP 100/ 316X -40  
 MIN, MAX VALUES = -23.058 34.00, 49.47 8 7.63



CRTC , 880107  
 SI PROTECTION PASS VEHICLE  
 88007  
 LFDYV3

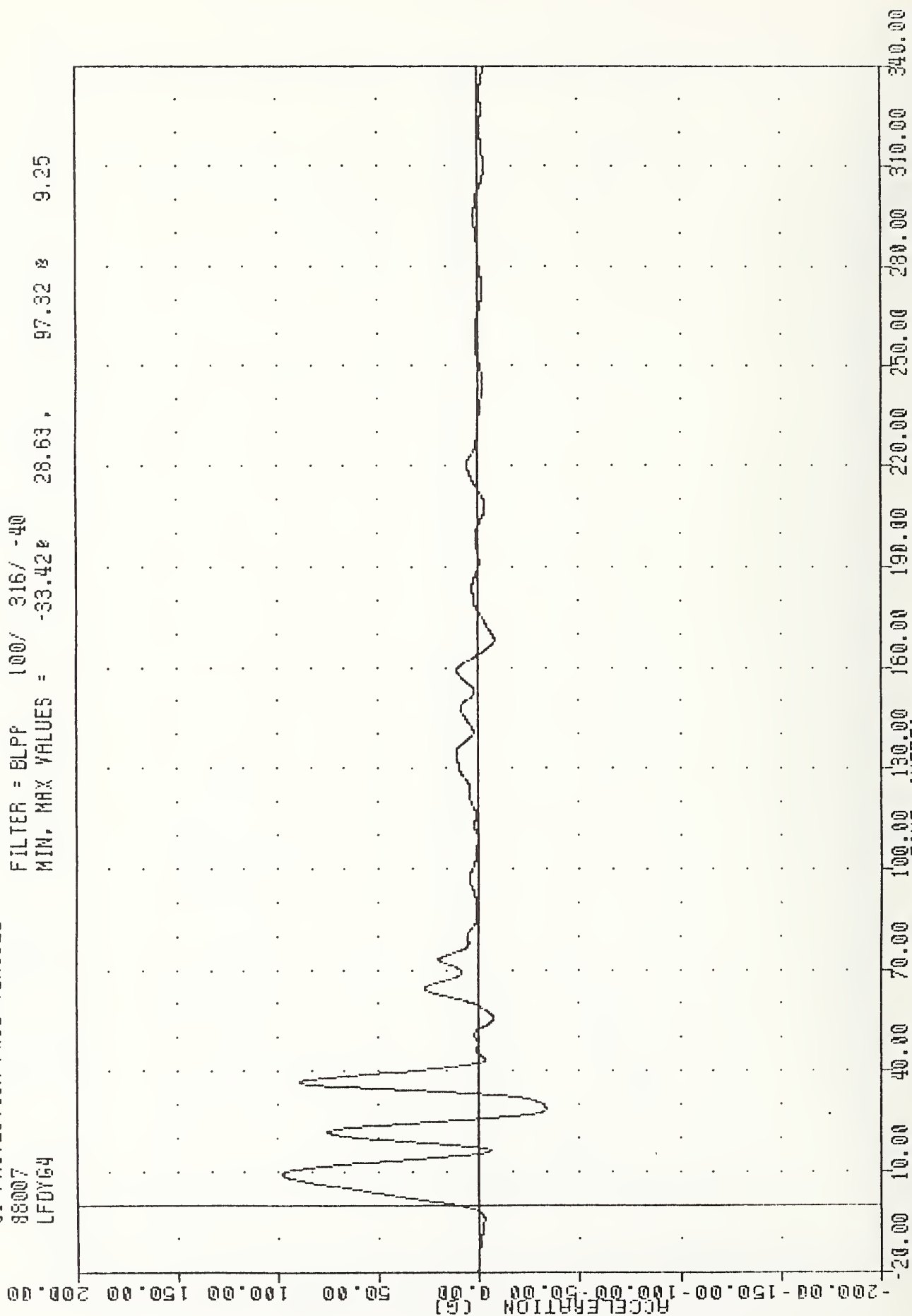
FILTER = BLPP 300/ 949/ -40  
 MIN, MAX VALUES = 0.00E -20.00 , 18.39 E 30.00



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 DELTA V USING LFDYV3

VRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 88007  
 LFDY64

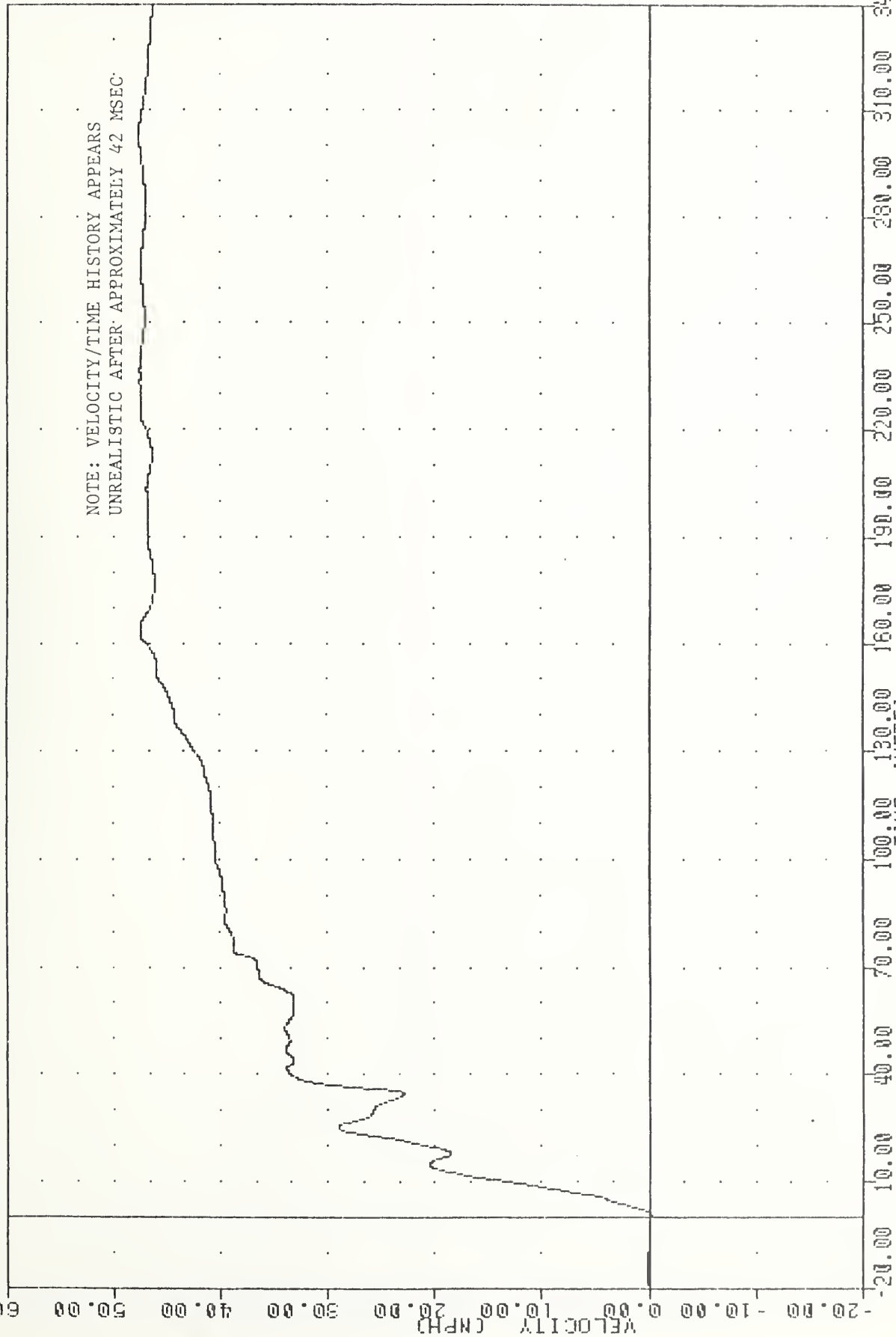
FILTER = BLPP 100/ 316/ -40  
 MIN, MAX VALUES = -33.428 28.63 , 97.32 8 9.25



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 VEHICLE LEFT FRONT DOOR (THORAX) Y AXIS ACCELERATION

NRIC , 880107  
 SI PROTECTION PROO VEHICLE  
 88007  
 LFDYV4

FILTER = BLPP 300/ 949/ -40  
 MIN. MAX VALUES = -0.212 0.25 , 47.60 2 302.75

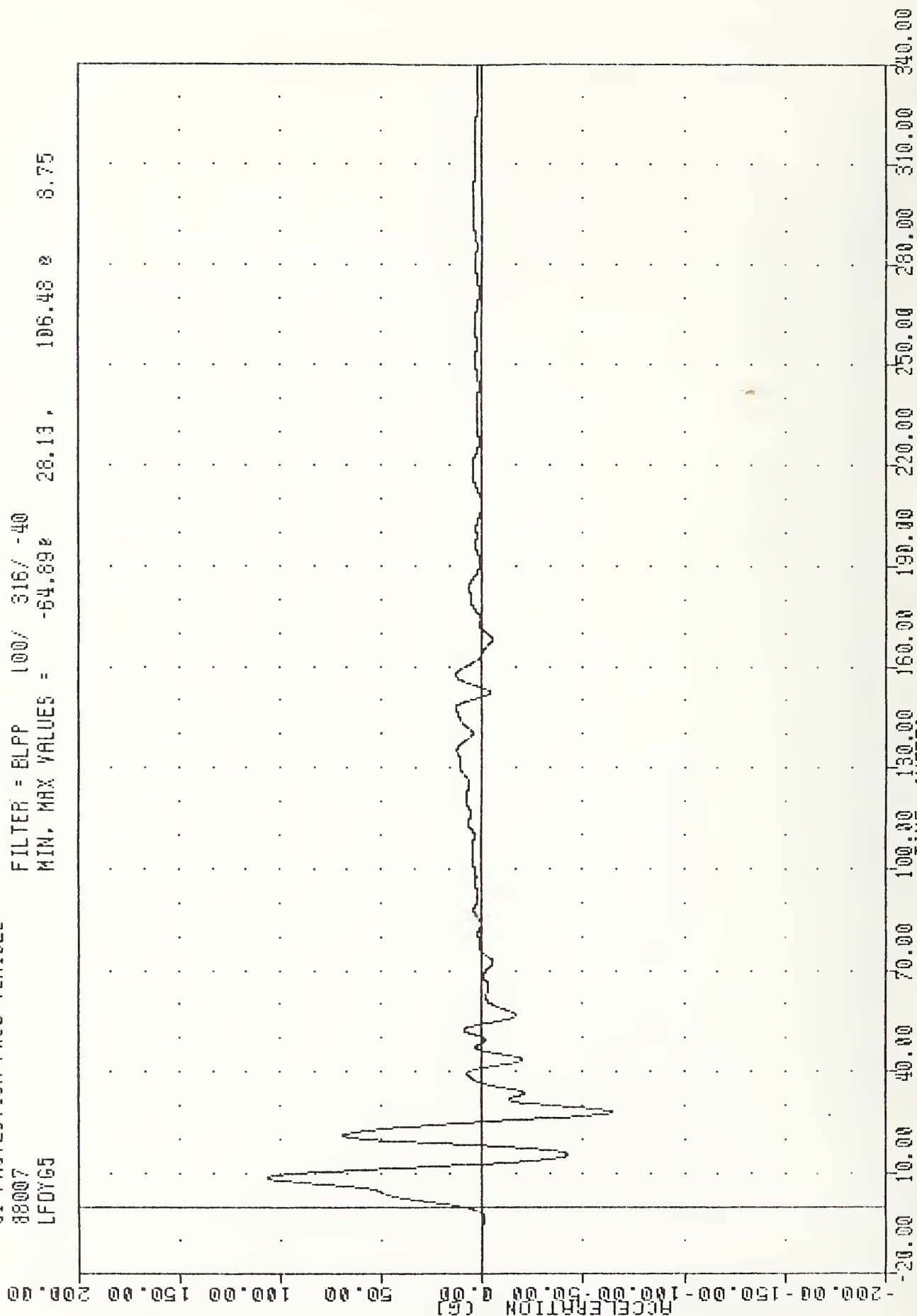


MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 DELTA V USING LFDYV4



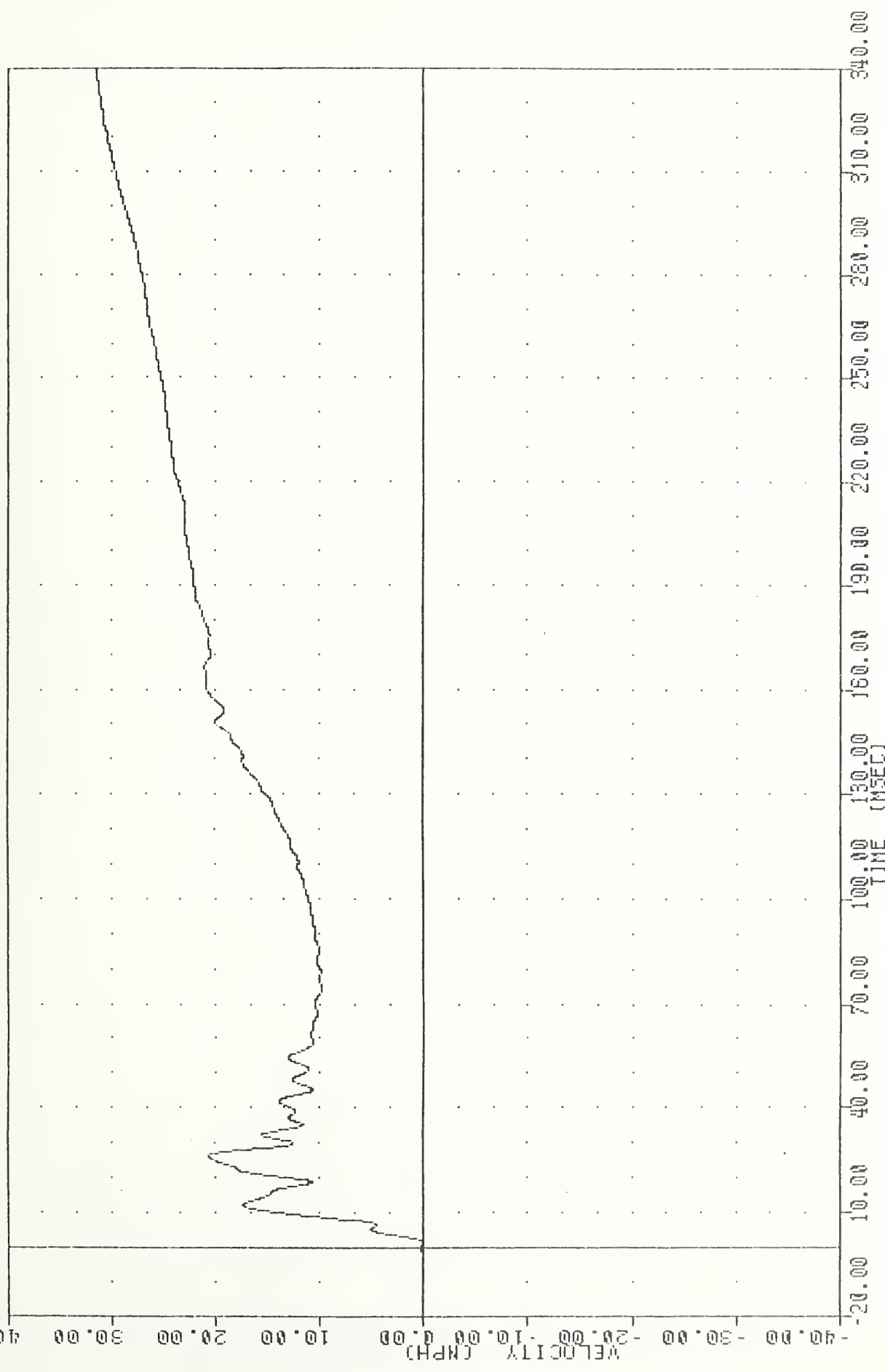
VRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 88007  
 LFDY65

FILTER = BLPP 100/ 316/ -40  
 MIN, MAX VALUES = -64.89% 28.13, 106.48 % 8.75



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 VEHICLE LEFT FRONT DOOR (THORAX) FORM BLOCK Y AXIS ACCELERATION

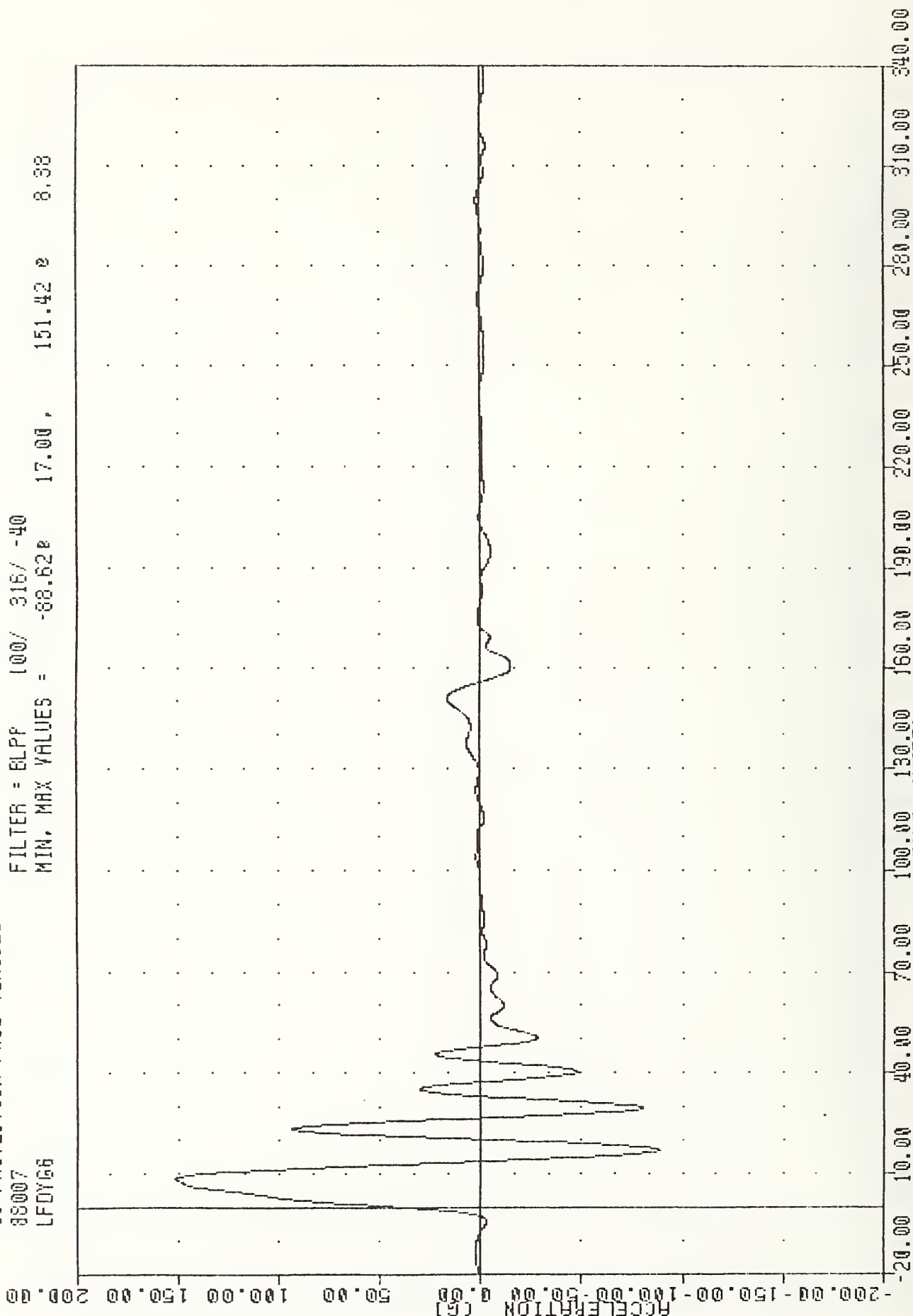
1. RTD  
 88007  
 LFDYV5  
 SI PROTECTION PROO VEHICLE  
 FILTER = BLPP 300/ 949/ -40  
 MIN. MAX VALUES = -0.012 -12.50 , 31.49 & 340.00



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 DELTA V USING LFDYV5

VR7C , 880107  
 SI PROTECTION PROD VEHICLE  
 88007  
 LFDY66

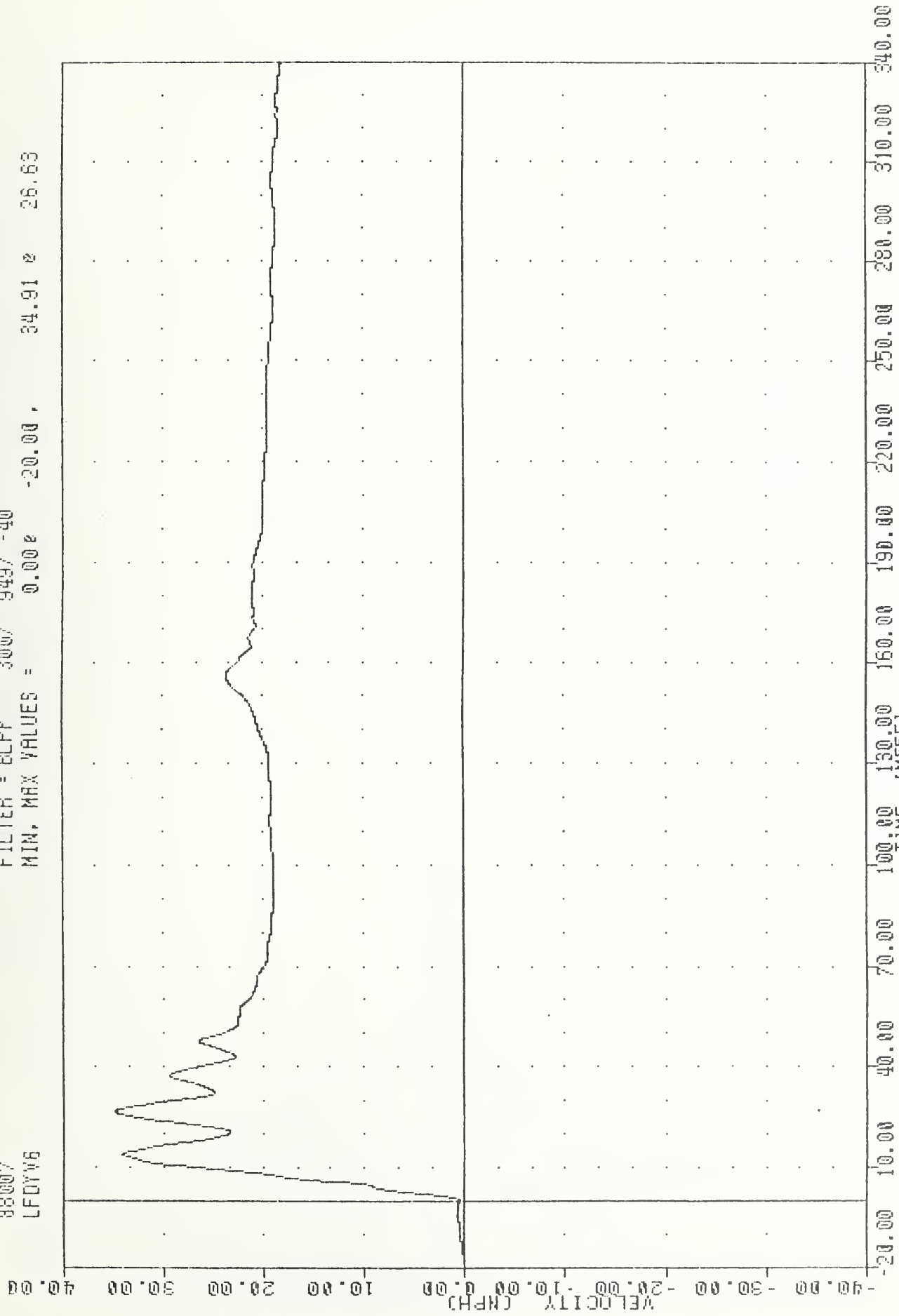
FILTER = ELPP 100/ 316/ -40  
 MIN, MAX VALUES = -88.628 17.00, 151.42 8 8.38



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 VEHICLE LEFT FRONT DOOR (H-POINT) Y AXIS ACCELERATION

VRTC , 880107  
 SI PROTECTION PROG VEHICLE  
 88007  
 LFDYV6

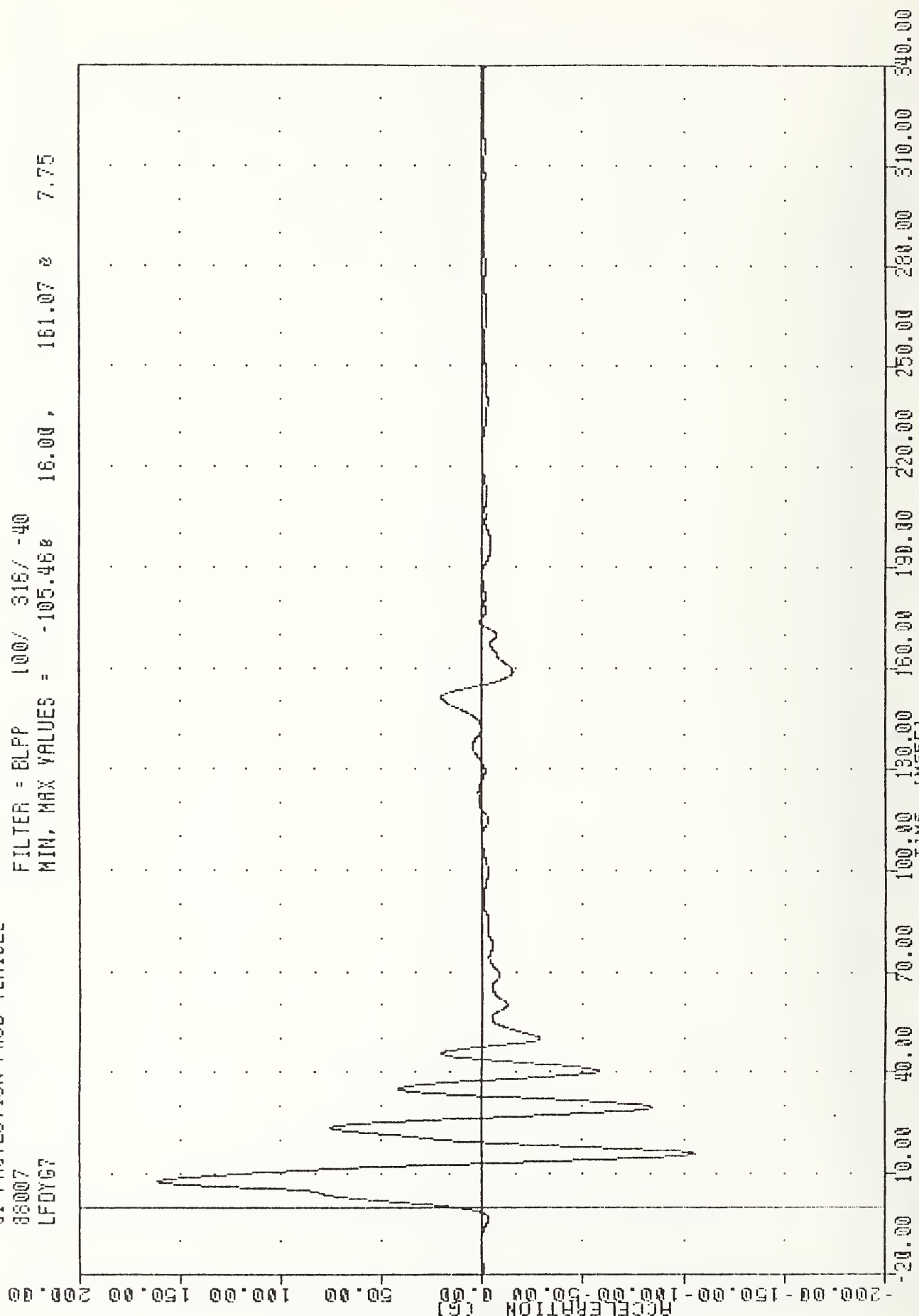
FILTER = BLPP 300/ 949/ -40  
 MIN, MAX VALUES = 0.00e -20.00 , 34.91 e 26.63



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 DELTA V USING LFDYV6

VRTC , 880107  
 SI PROTECTION PASS VEHICLE  
 88007  
 LFDY67

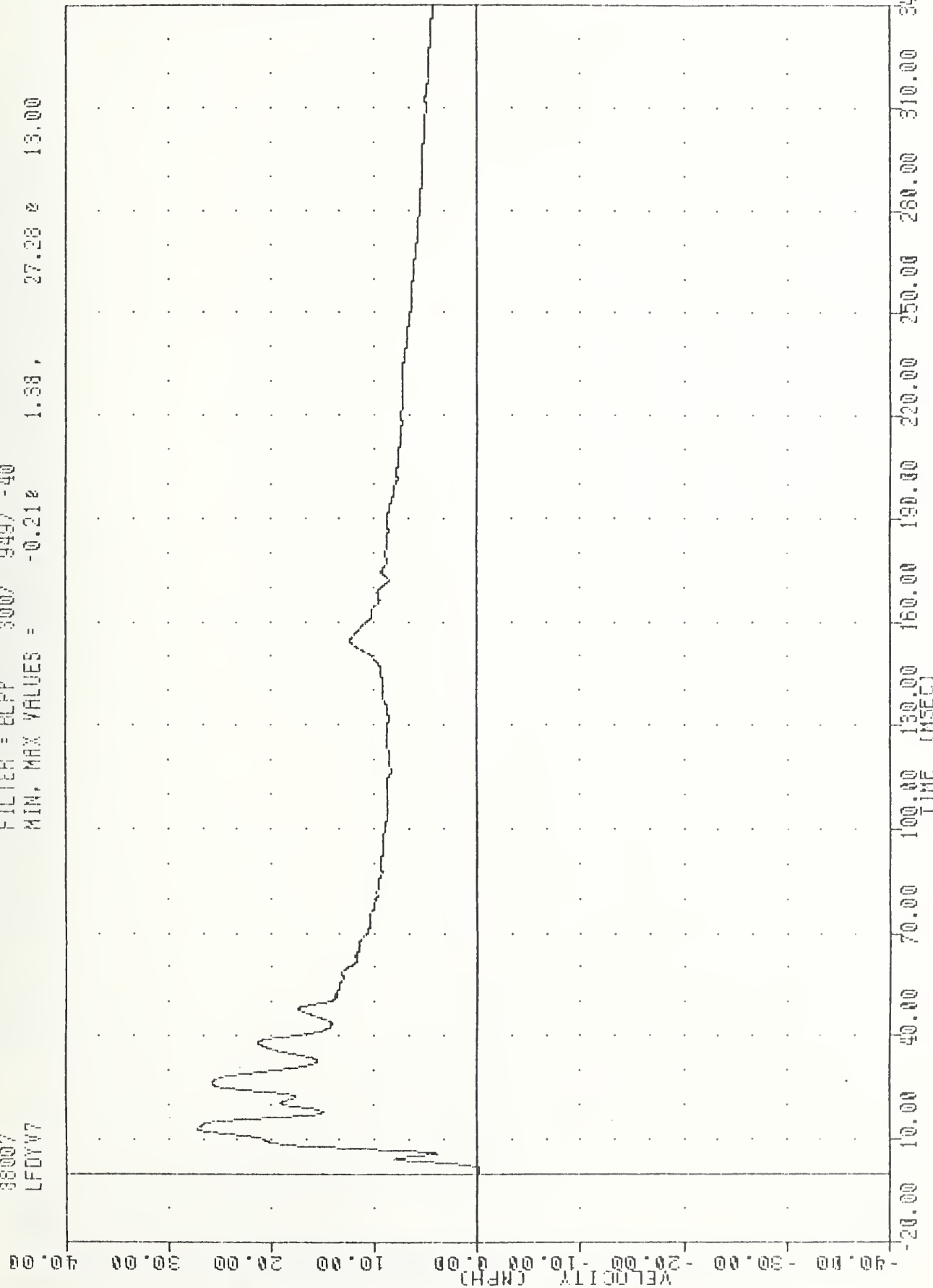
FILTER = BLPP 100/ 316/ -40  
 MIN, MAX VALUES = -105.468 16.00, 161.07 2 7.75



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 VEHICLE LEFT FRONT DOOR (H-POINT) FORM BLOCK Y AXIS ACCELERATION

VR7C 880107  
 31 PROTECTION PROD VEHICLE  
 88007  
 LFDYV7

FILTER = BLPP 300/ 949/ -40  
 MIN, MAX VALUES = -0.218 1.58, 27.28 2 13.00

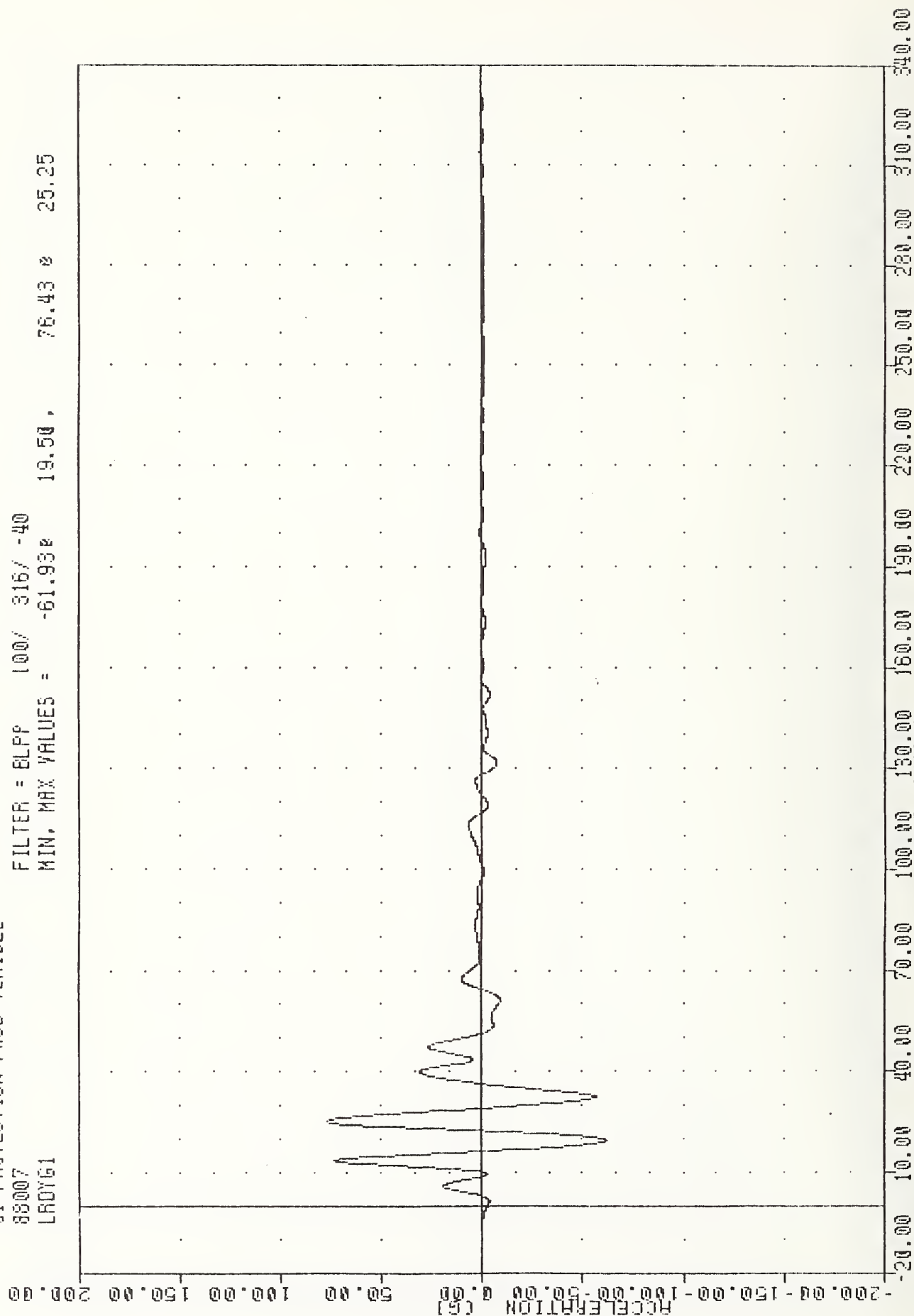


MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 DELTA V USING LFDYV7



VR7C , 880107  
 SI PROTECTION PASS VEHICLE  
 880007  
 LRDY61

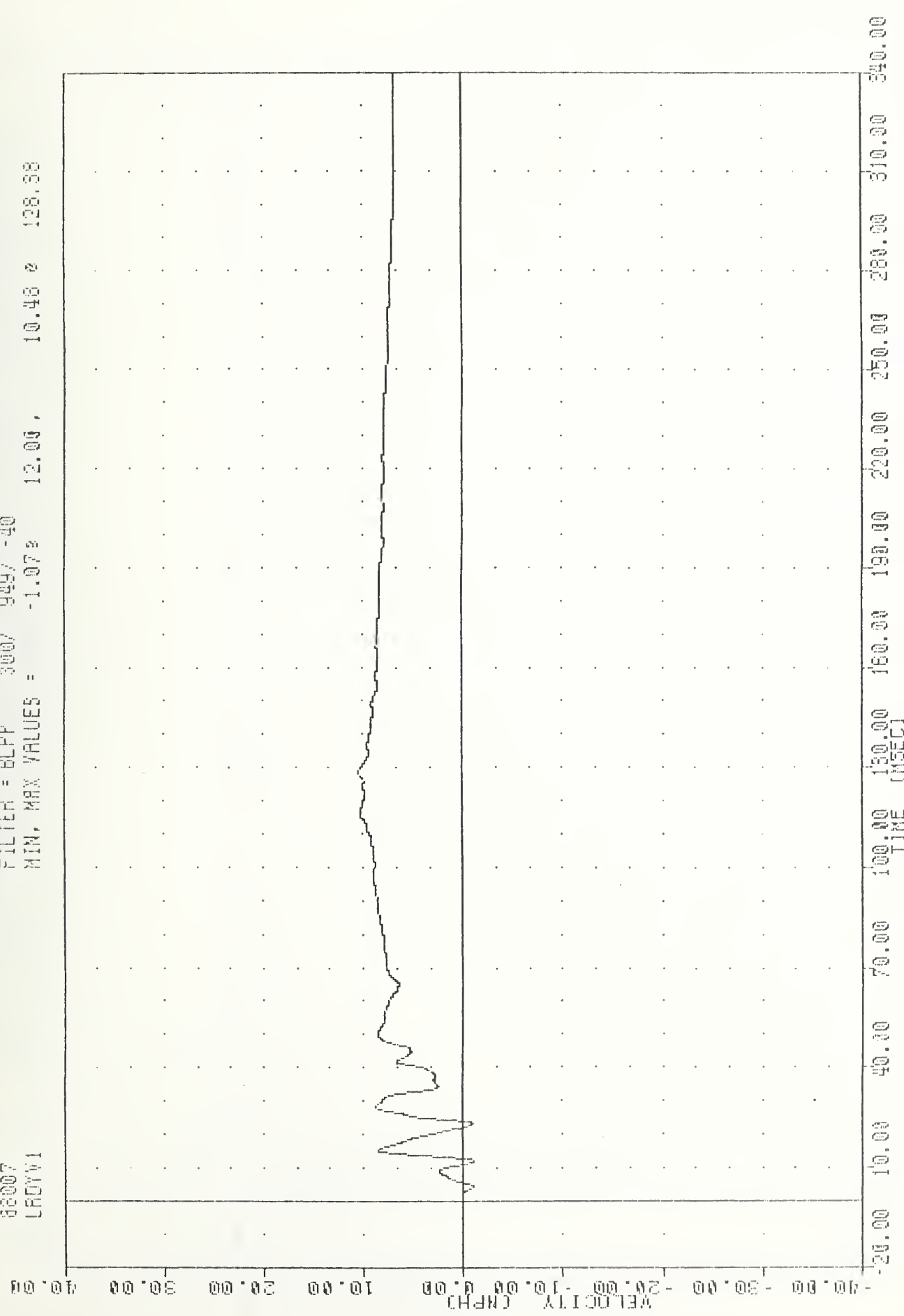
FILTER = ELPP 100/ 316/ -40  
 MIN, MAX VALUES = -61.93% 19.50, 76.43 % 25.25



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 VEHICLE LEFT REAR DOOR (THORAX) FORM BLOCK Y AXIS ACCELERATION

V87C , 880107  
 SI PROTECTION PROO VEHICLE  
 88007  
 LRDYV1

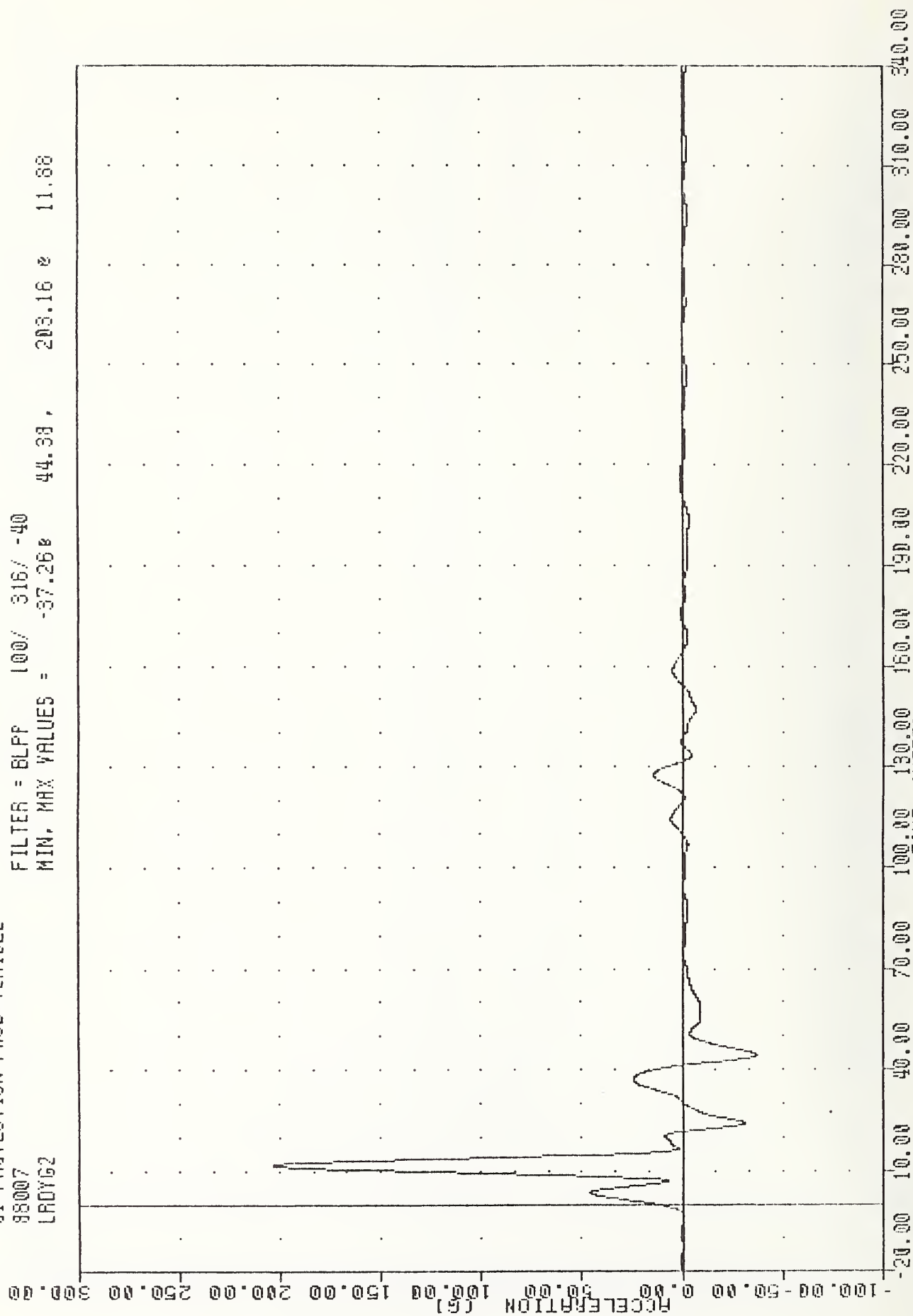
FILTER = BLPP 300/ 949/ -40  
 MIN, MAX VALUES = -1.07% 12.00, 10.46 & 128.33



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 DELTA V USING LRDYV1

NRIC , 880107  
 SI PROTECTION PROD VEHICLE  
 98007  
 LRDY62

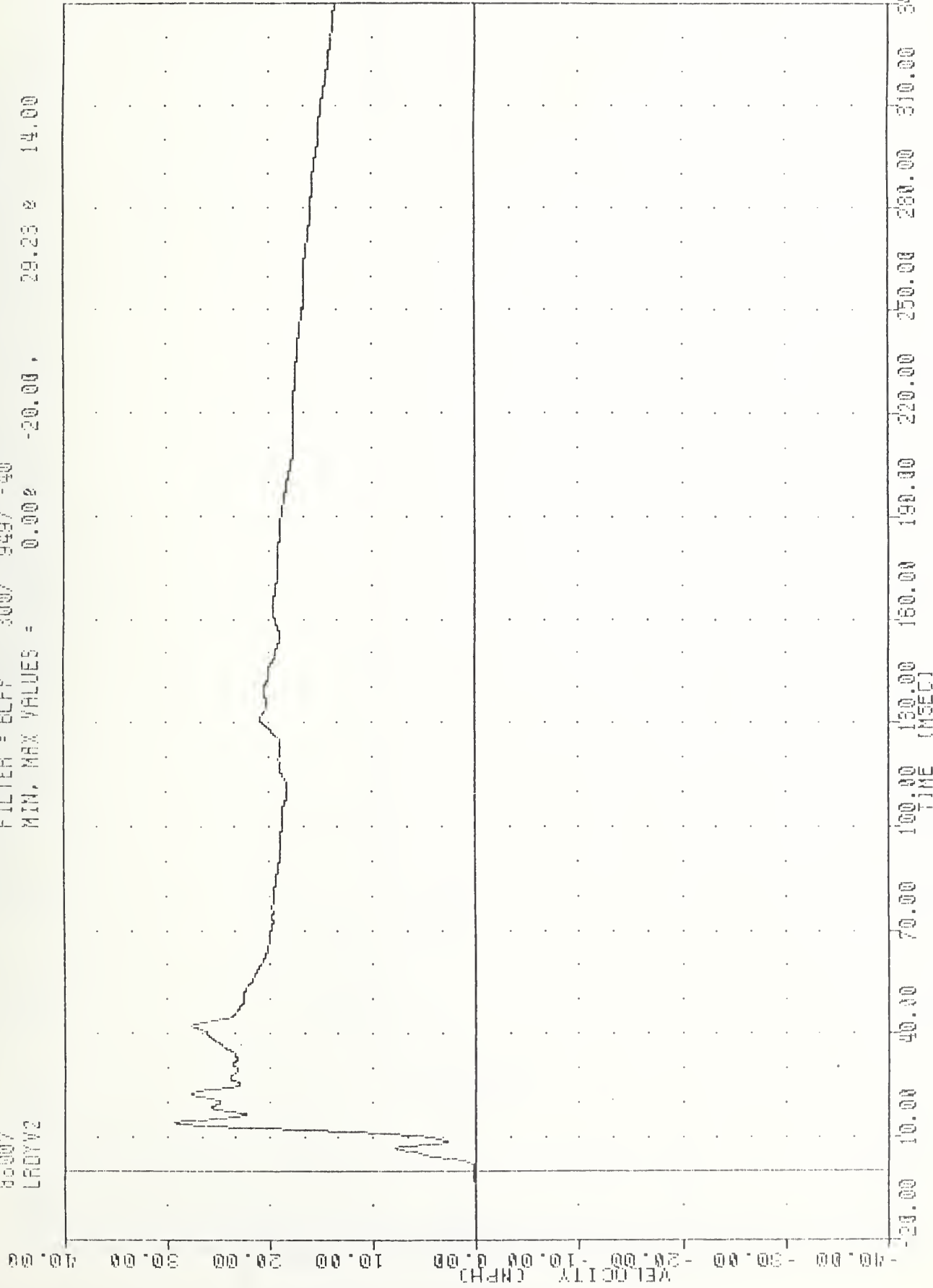
FILTER = BLPP 100/ 316/ -40  
 MIN, MAX VALUES = -37.26 44.33 , 203.16 11.88



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 VEHICLE LEFT REAR DOOR (H-POINT) FOAM BLOCK Y AXIS ACCELERATION

1-70 860197  
91 PROTECTION FROM VEHICLE  
86007  
LADYV2

FILTER = BLFF 300/ 949/ -40  
MIN. MAX VALUES = 0.002 -20.00 29.23 14.00

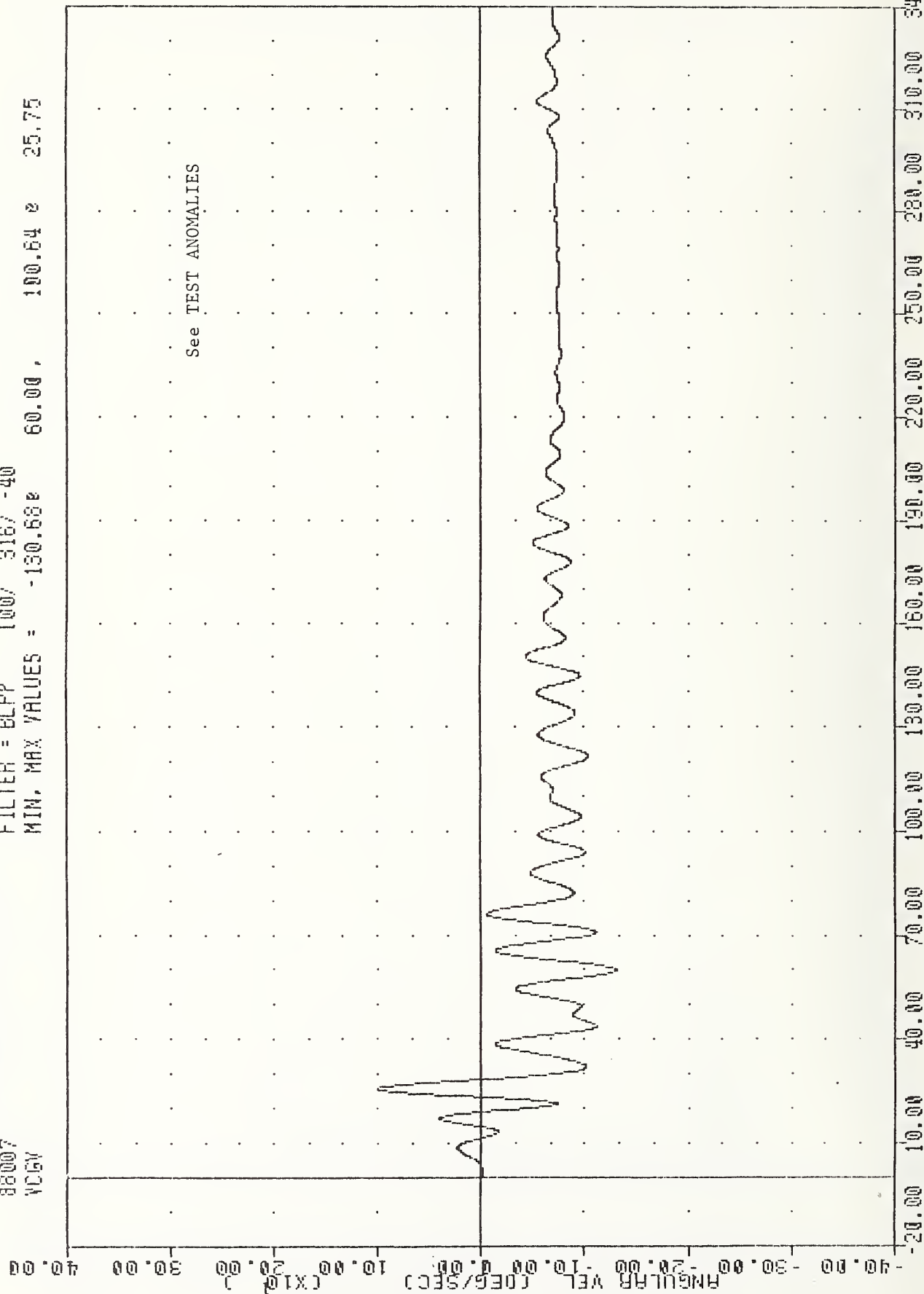


MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
DELTA V USING LADYV2

VRTC  
SI PROTECTION PROD VEHICLE  
88007  
VCGV

, 880107

FILTER = BLPP 100/ 316/ -40  
MIN. MAX VALUES = -130.68 60.00, 100.64 25.75

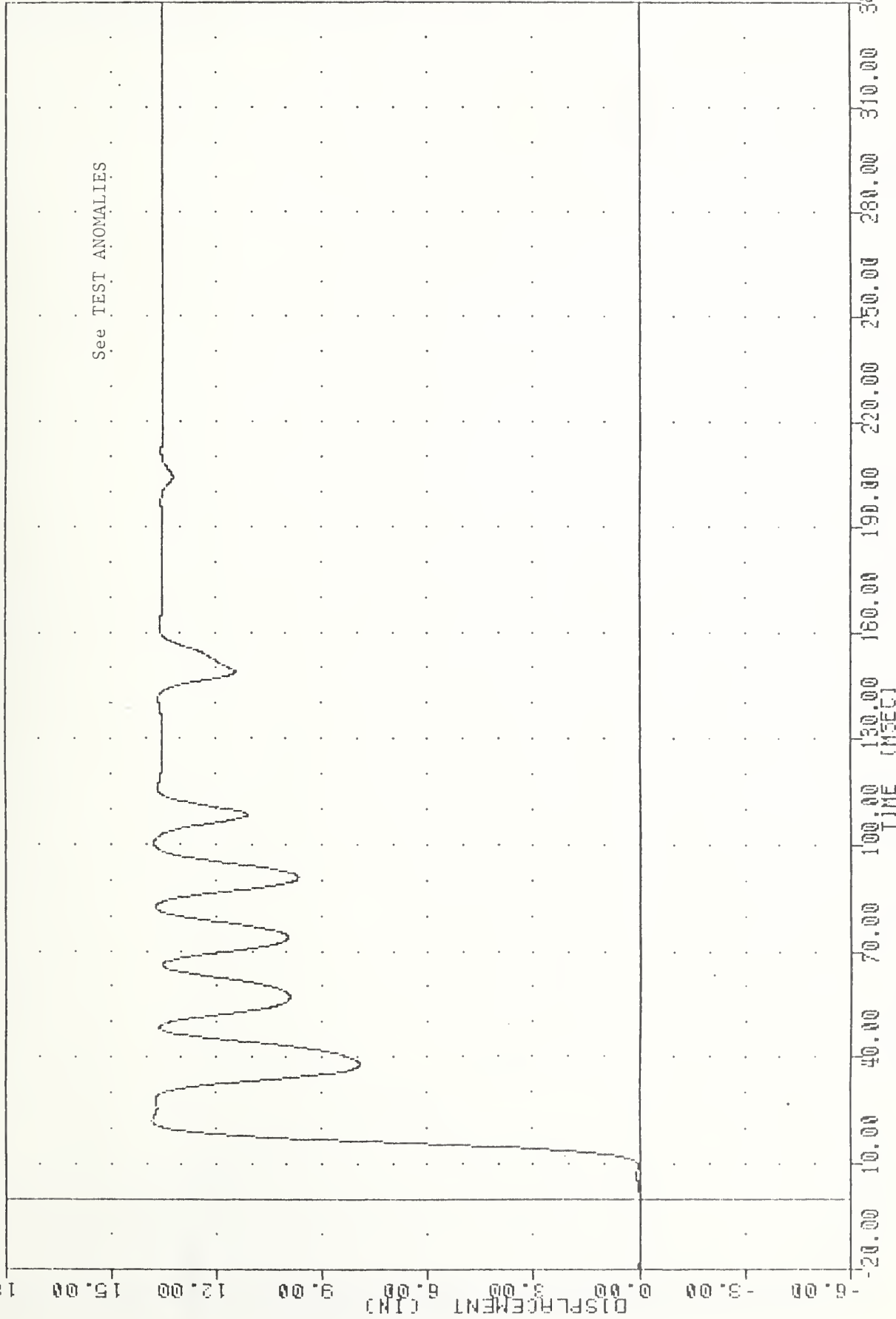


See TEST ANOMALIES

MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
VEHICLE YAW RATE (DEGREES/SEC)

WRTC, 880107  
 SI PROTECTION PROO VEHICLE  
 88007  
 LFOVD1

FILTER = ELPP 100/ 316/ -40  
 MIN. MAX VALUES = -0.01e -0.38, 13.81 e 22.13

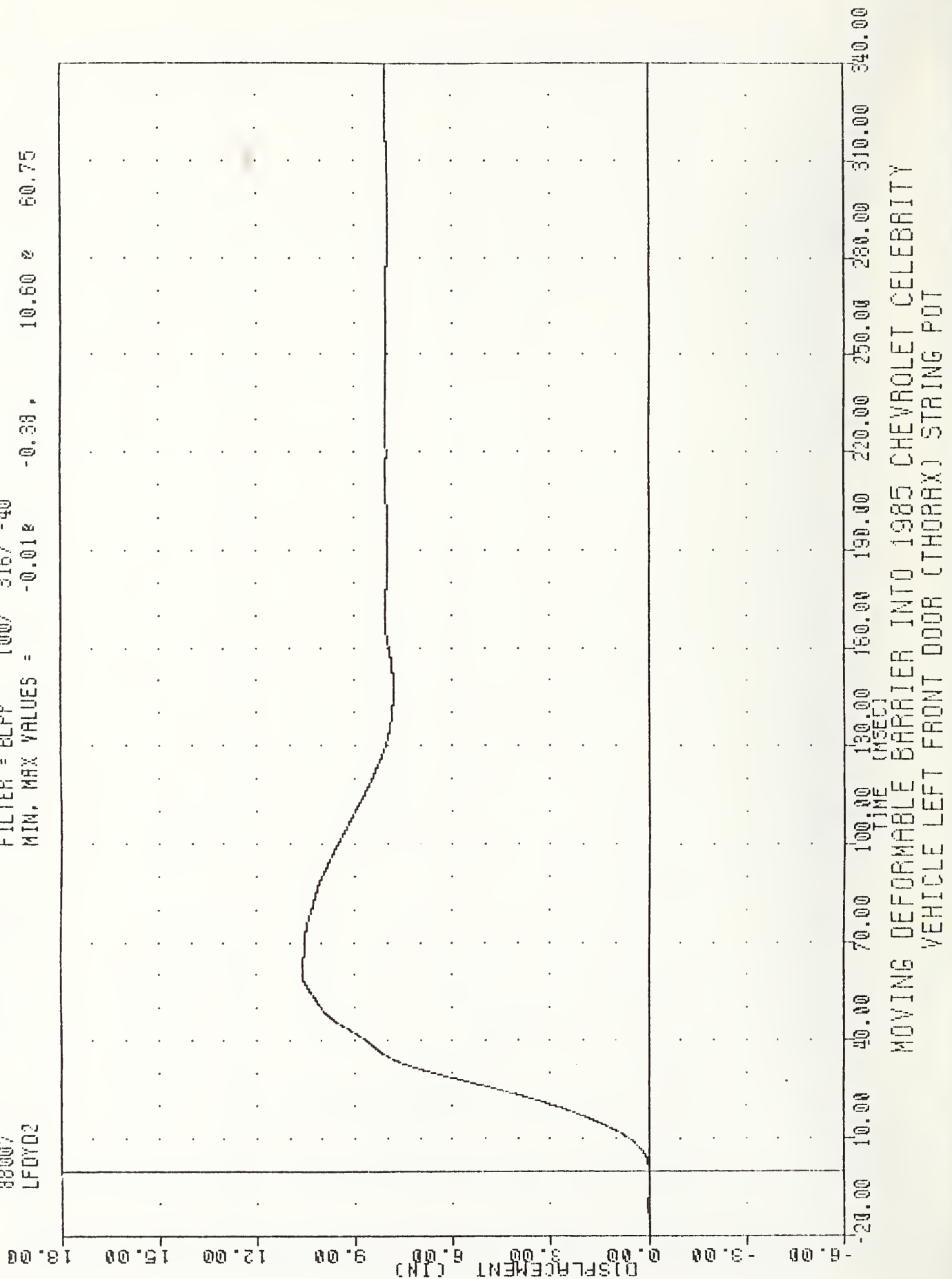


MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 VEHICLE LEFT FRONT DOOR (THORAX) LINEAR POT



VRTC , 680107  
 SI PROTECTION PROD VEHICLE  
 88007  
 LFOYD2

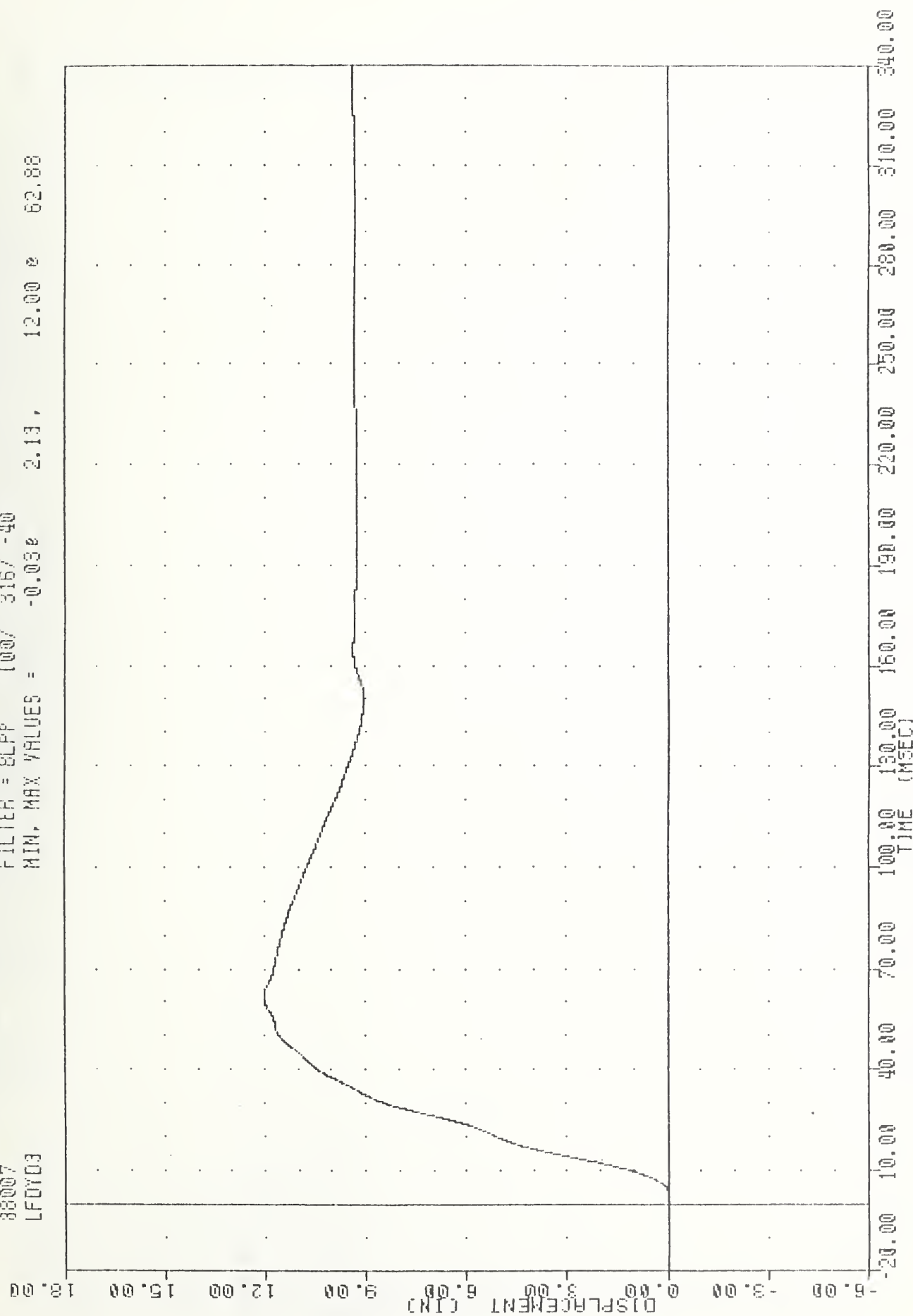
FILTER = BLPP 100/ 316/ -40  
 MIN, MAX VALUES = -0.018 -0.38 , 10.60 8 60.75



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 VEHICLE LEFT FRONT DOOR (THORAX) STRING POT

WRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 88007  
 LFDYD3

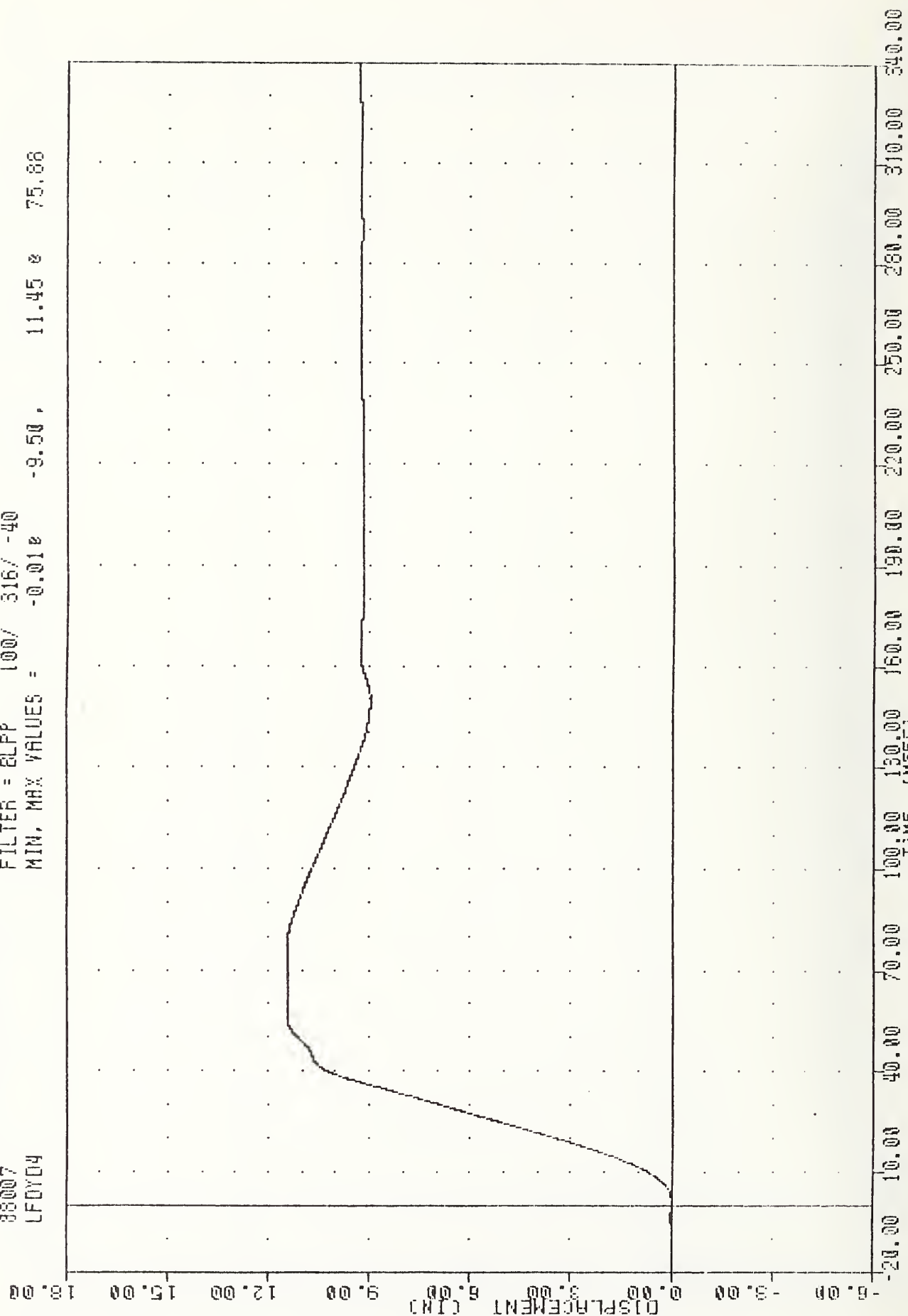
FILTER = SLPP 100/ 316/ -40  
 MIN, MAX VALUES = -0.03e 2.13, 12.00 e 62.88



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 VEHICLE LEFT FRONT DOOR (H-POINT) LINEAR POT

VRTC , 880107  
 SI PROTECTION PASS VEHICLE  
 88007  
 LFDY04

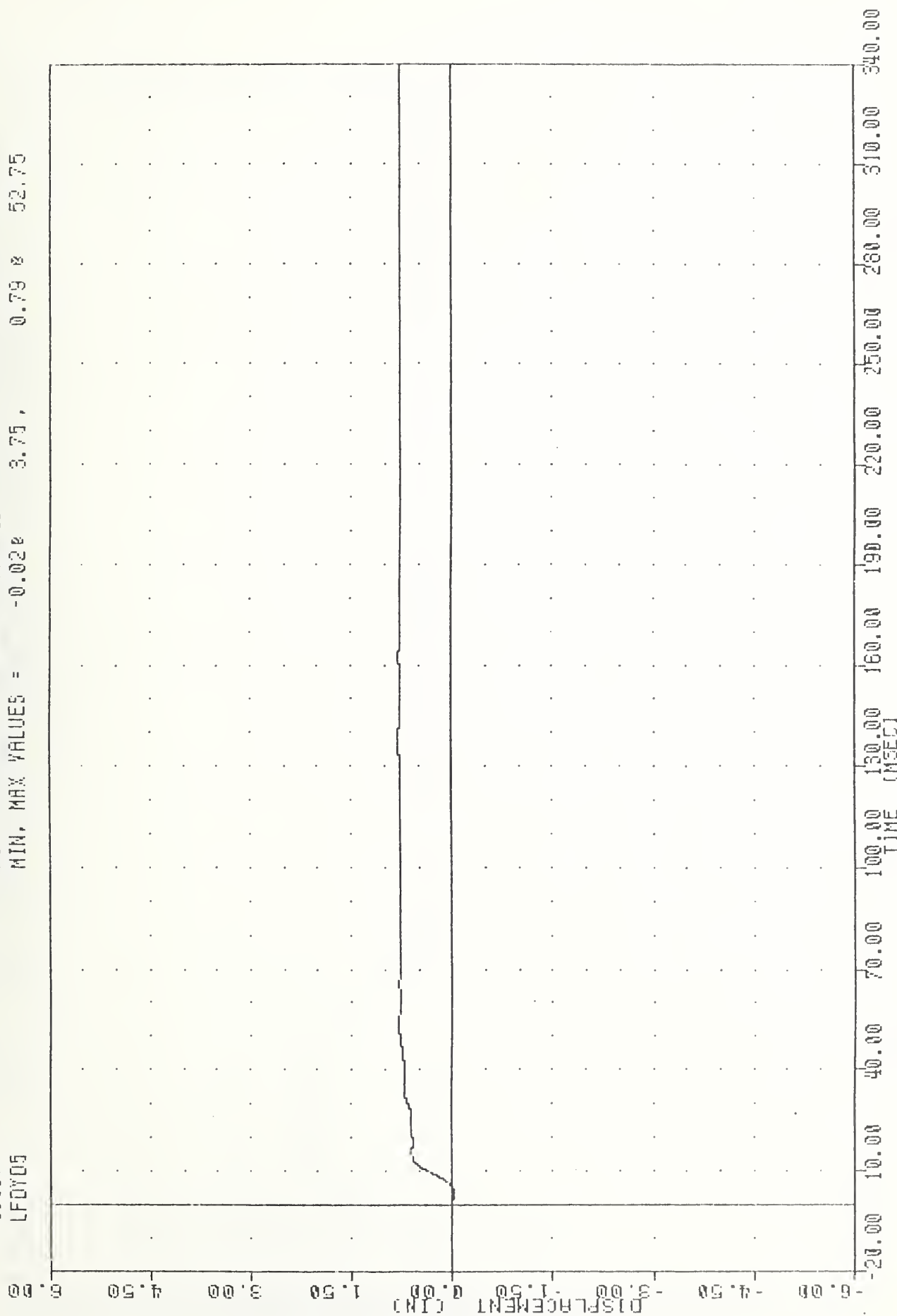
FILTER = ELPP 100/ 316/ -40  
 MIN, MAX VALUES = -0.01e -9.50, 11.45 e 75.88



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 VEHICLE LEFT FRONT DOOR (H-POINT) STRAINING POT

VRTC , 880107  
 SI PROTECTION FROM VEHICLE  
 88007  
 LFOY05

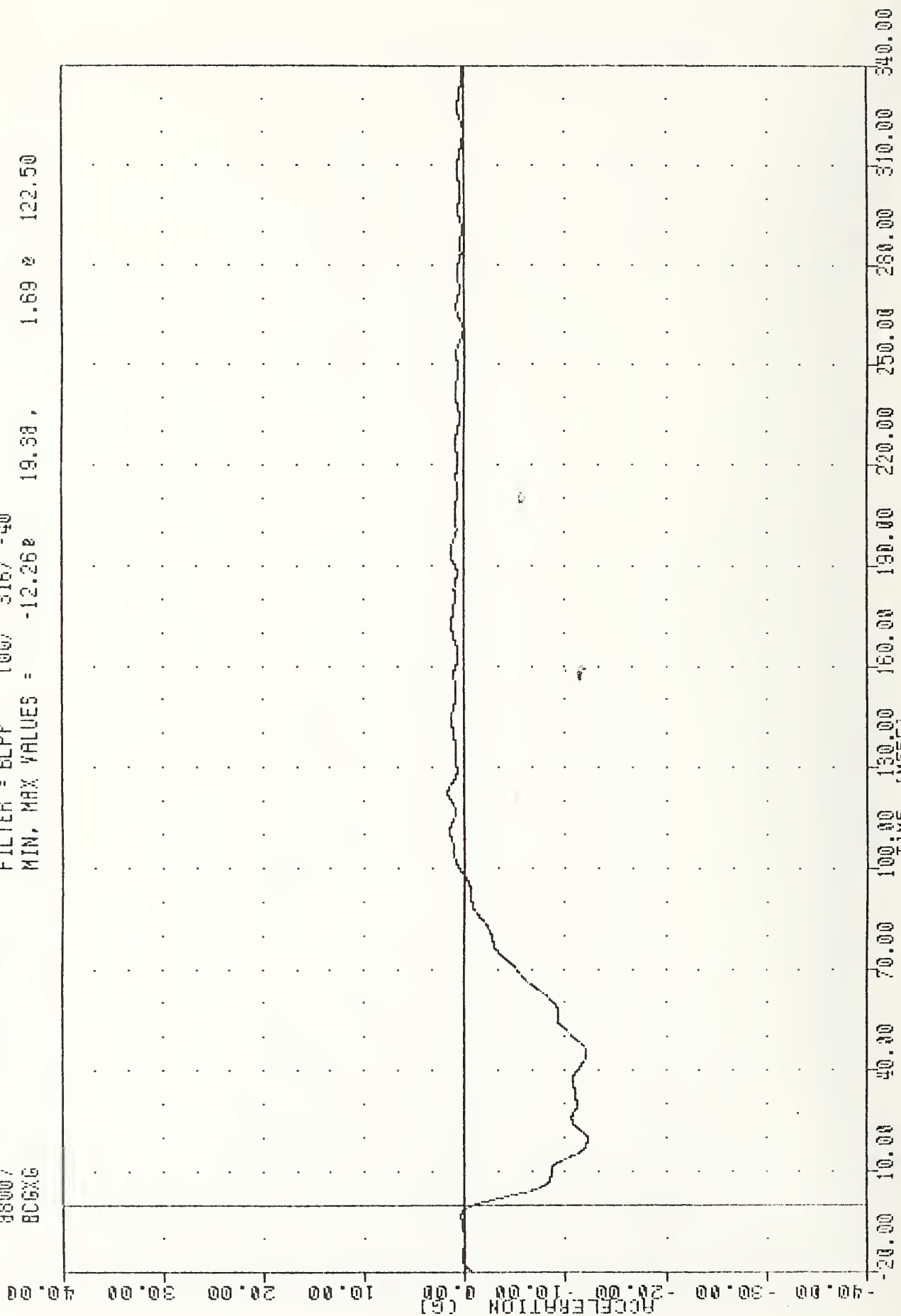
FILTER = 8LFF 100/ 316/ -40  
 MIN, MAX VALUES = 3.75, 0.79 & 52.75



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 VEHICLE LEFT FRONT DOOR (OUTER) LINEAR POT

VRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 88007  
 BCGXG

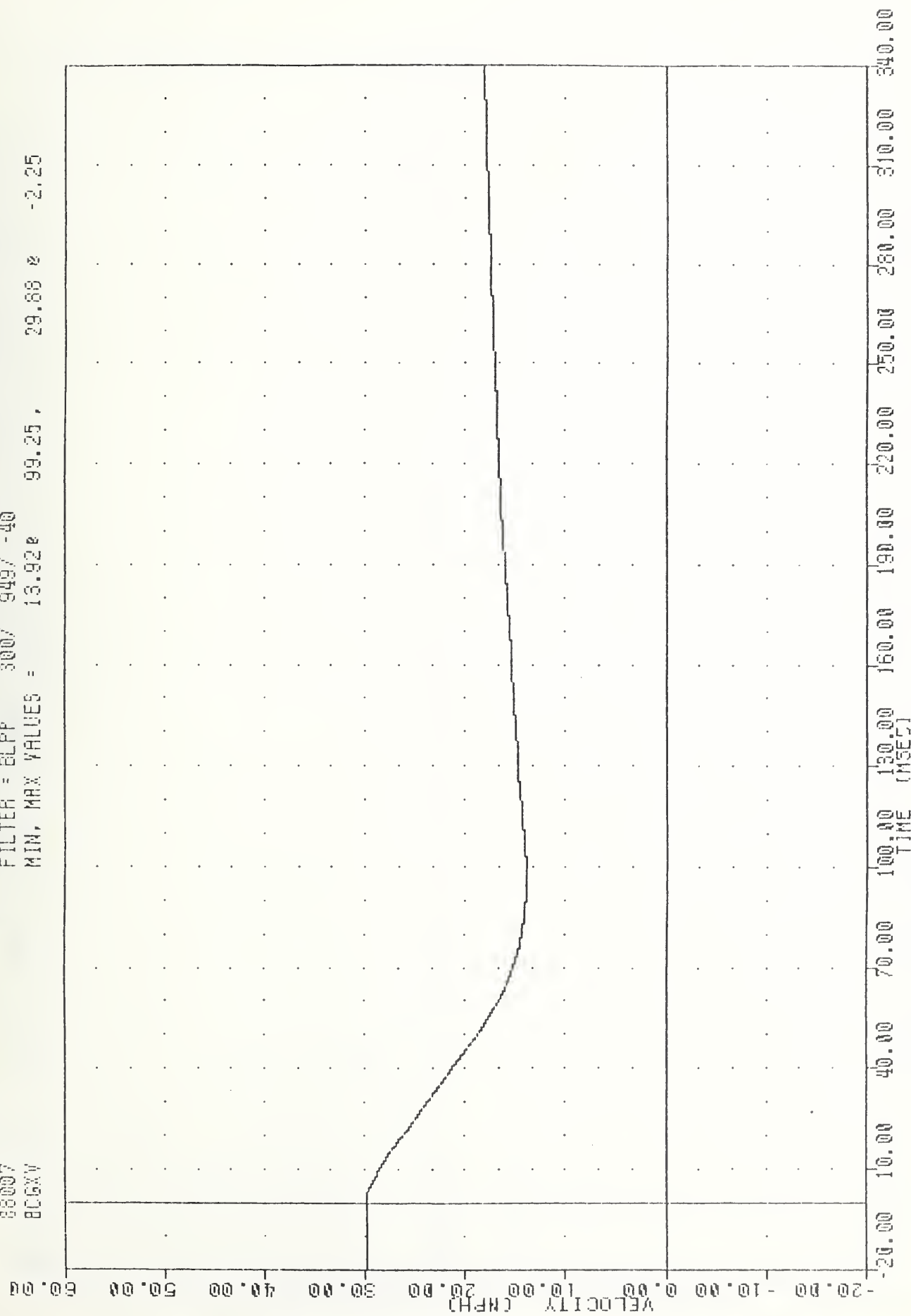
FILTER = BLPP 100/ 316/ -40  
 MIN. MAX VALUES = -12.26e 19.58 , 1.69 e 122.50



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 BARRIER CENTER OF GRAVITY X AXIS ACCELERATION

NRTC , 880107  
 SI PROTECTION PASS VEHICLE  
 88007  
 BCGXV

FILTER = BLPP 300/ 949/ -40  
 MIN, MAX VALUES = 13.92 99.25 , 29.68 -2.25



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 DELTA V USING BCGXG

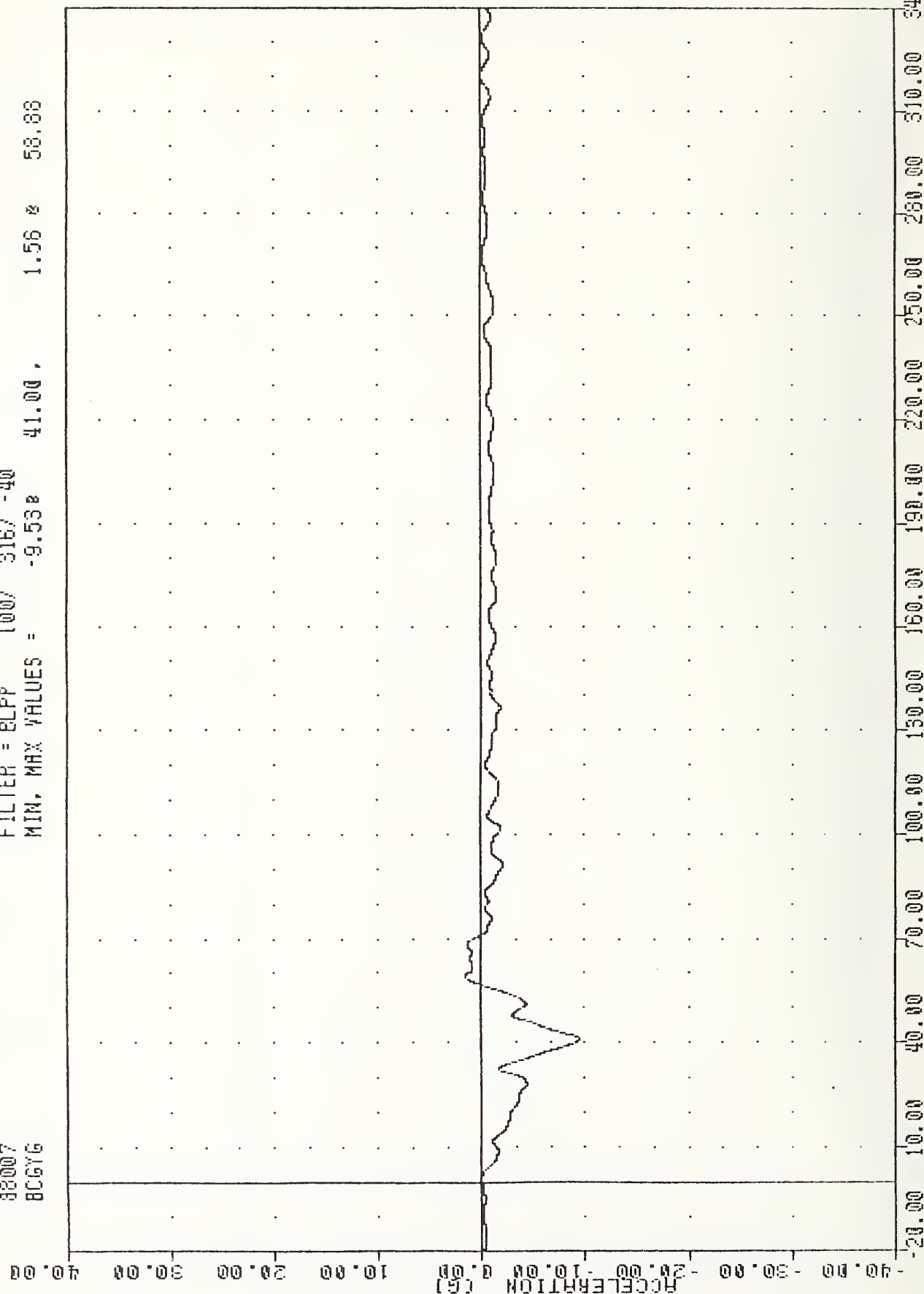


VRTC  
SI PROTECTION PADD VEHICLE

880007  
880007

BCGYG

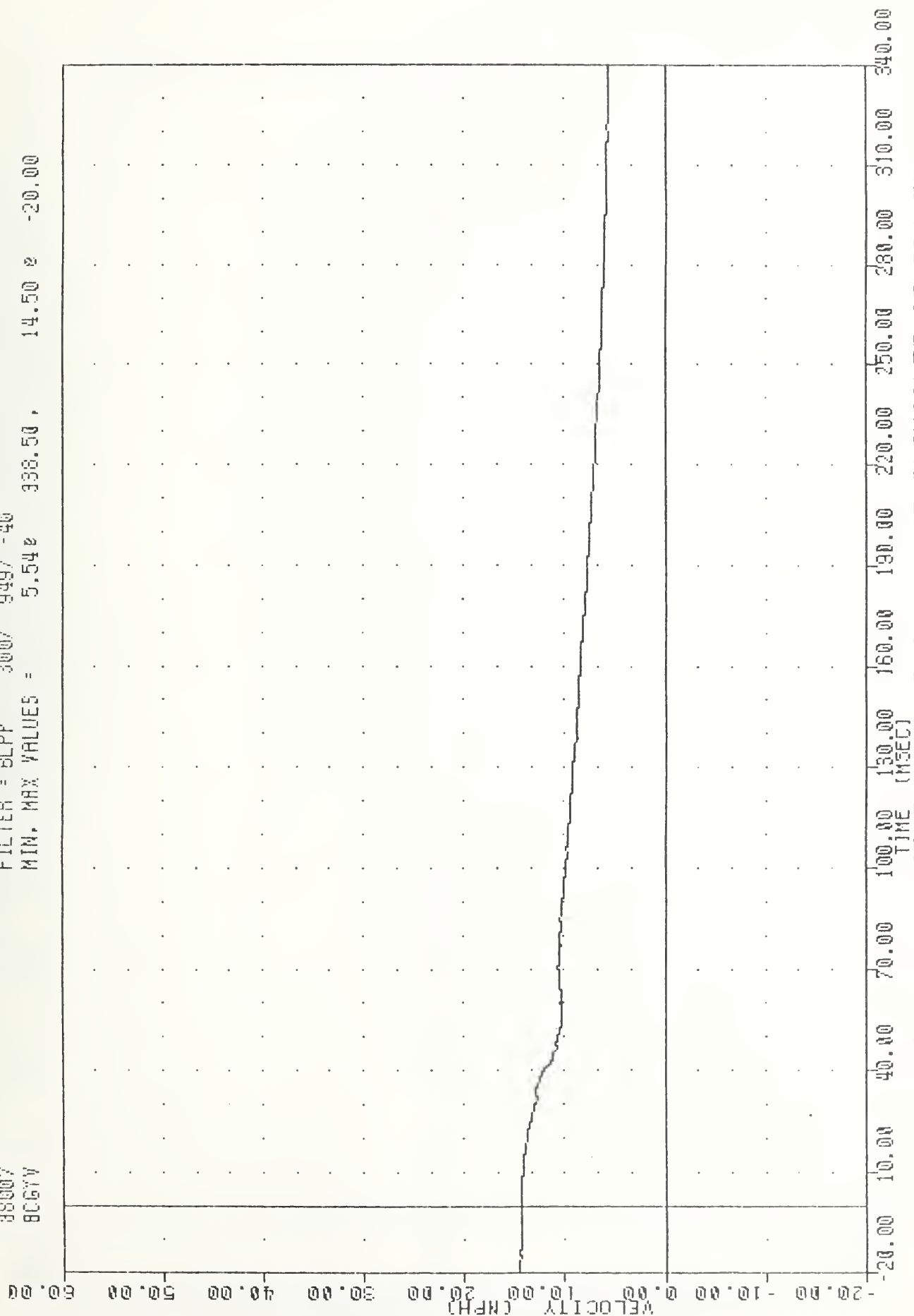
FILTER = BLPP 100/ 316/ -40  
MIN, MAX VALUES = -9.53g 41.00, 1.56 g 53.88



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
BARRIER CENTER OF GRAVITY Y AXIS ACCELERATION

VRTO , 800107  
 SI PROTECTION FROM VEHICLE  
 88007  
 BCGYV

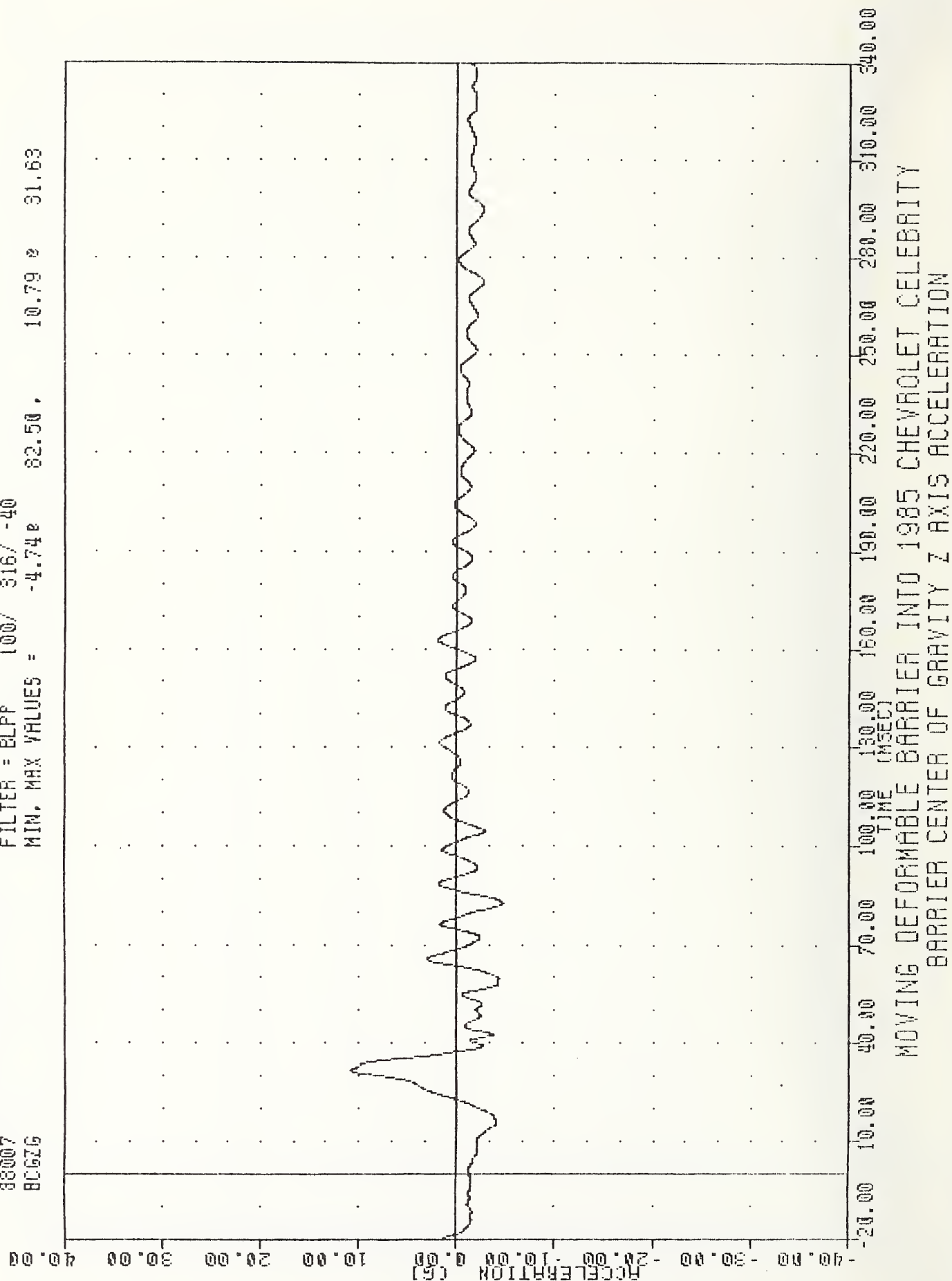
FILTER = BLPP 300/ 949/ -40  
 MIN. MAX VALUES = 5.54e 338.50 , 14.50 e -20.00



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 DELTA V USING BCGYG

VRTC , 880107  
 SI PROTECTION PROD VEHICLE  
 88007  
 BCGZG

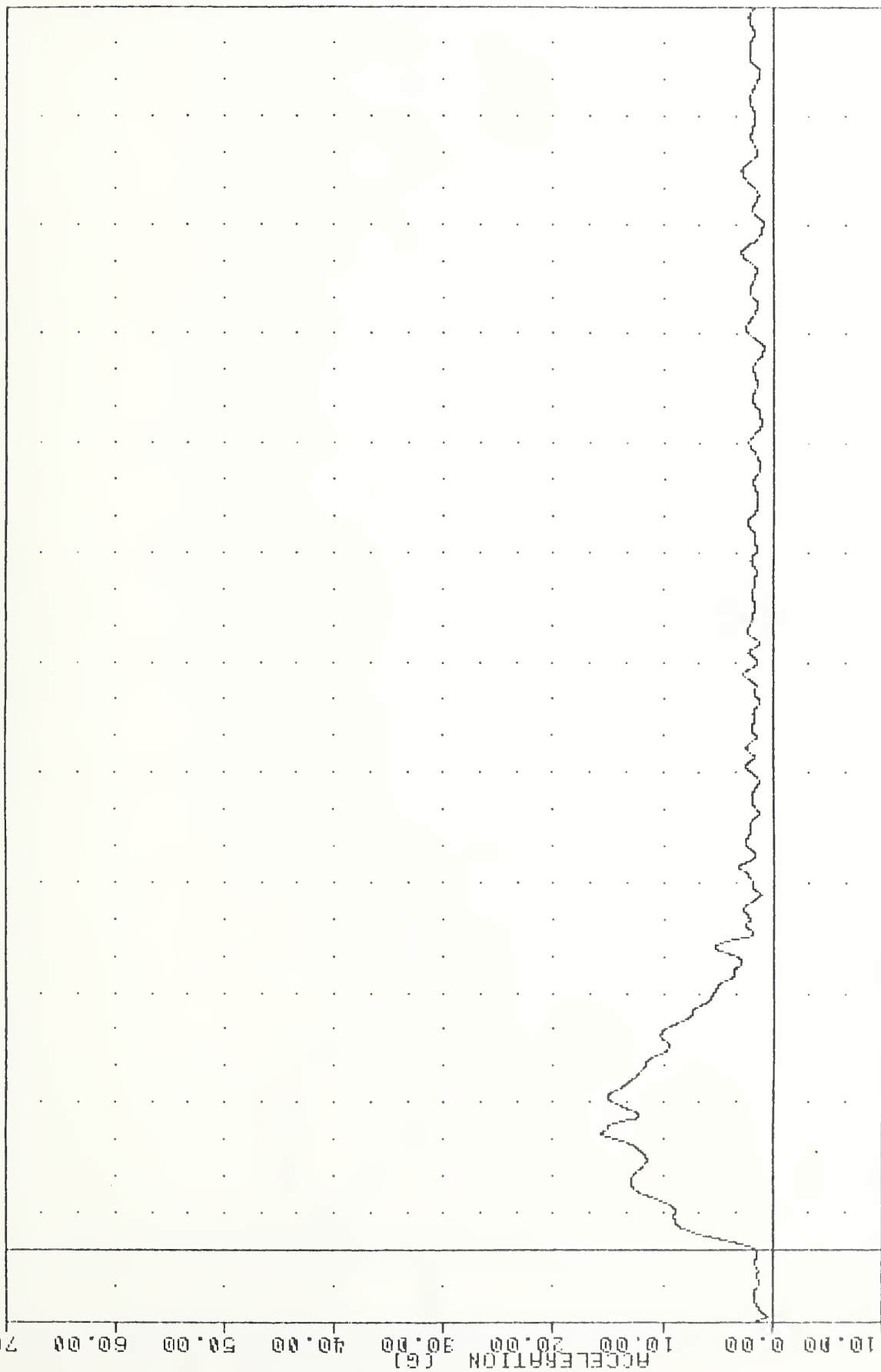
FILTER = BLPP 100/ 316/ -40  
 MIN. MAX VALUES = -4.74e 82.50. 10.79 e 31.63



VRTC , 880107  
 SI PROTECTION PAD VEHICLE  
 88007  
 80686

FILTER = BLPP 100/ 316/ -40  
 MIN. MAX VALUES = 0.47e -18.63, 15.58 e 31.50

70.00

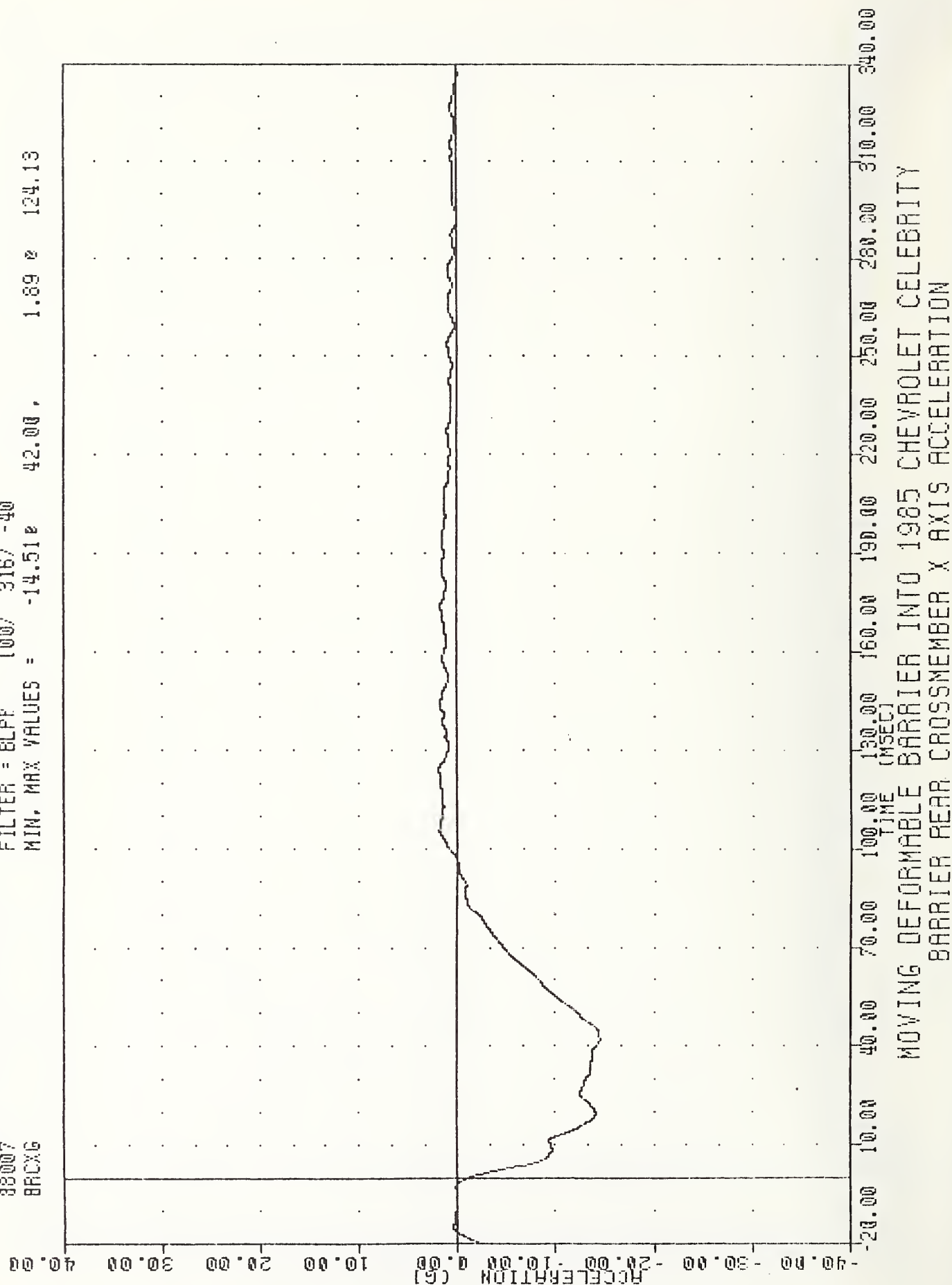


-20.00 10.00 20.00 30.00 40.00 50.00 60.00 70.00 80.00 90.00 100.00 110.00 120.00 130.00 140.00 150.00 160.00 170.00 180.00 190.00 200.00 210.00 220.00 230.00 240.00 250.00 260.00 270.00 280.00 290.00 300.00 310.00 320.00 330.00 340.00  
 MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 BARRIER CG RESULTANT ACCELERATION

VRTC , 880107  
 SI PROTECTION PADD VEHICLE

88007  
 BRXG

FILTER = BLPF 100/ 316/ -40  
 MIN. MAX VALUES = -14.51e 42.00 , 1.89 e 124.13



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 BARRIER REAR CROSSMEMBER X AXIS ACCELERATION

VRTD , 880107  
 SI PROTECTION PASS VEHICLE  
 880007  
 BRGXV

FILTER = BLPP 300/ 949/ -40  
 MIN. MAX VALUES = 12.15 29.61 2 -10.50

50.00

40.00

30.00

20.00

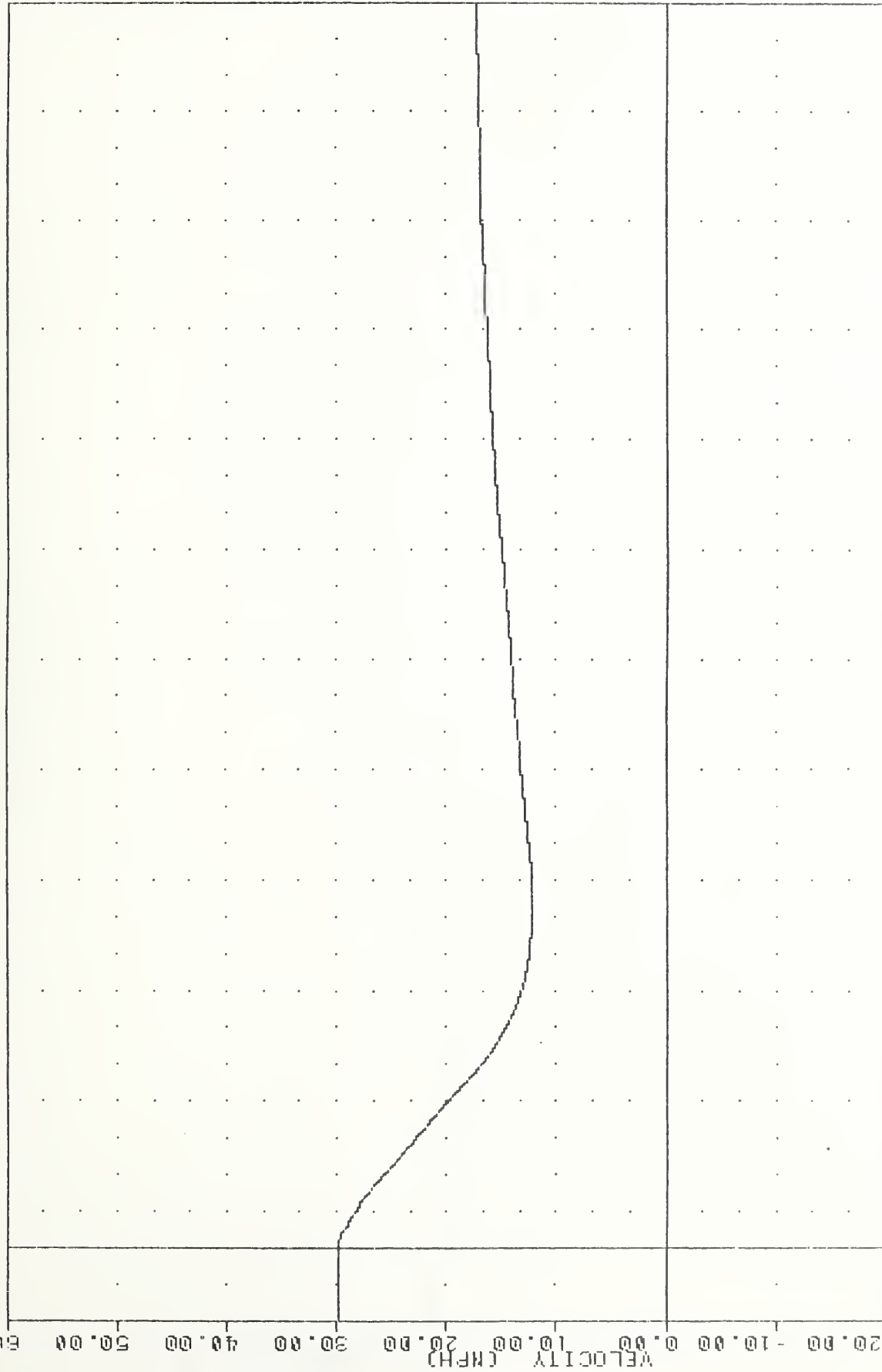
10.00

0.00

-10.00

-20.00

B-49

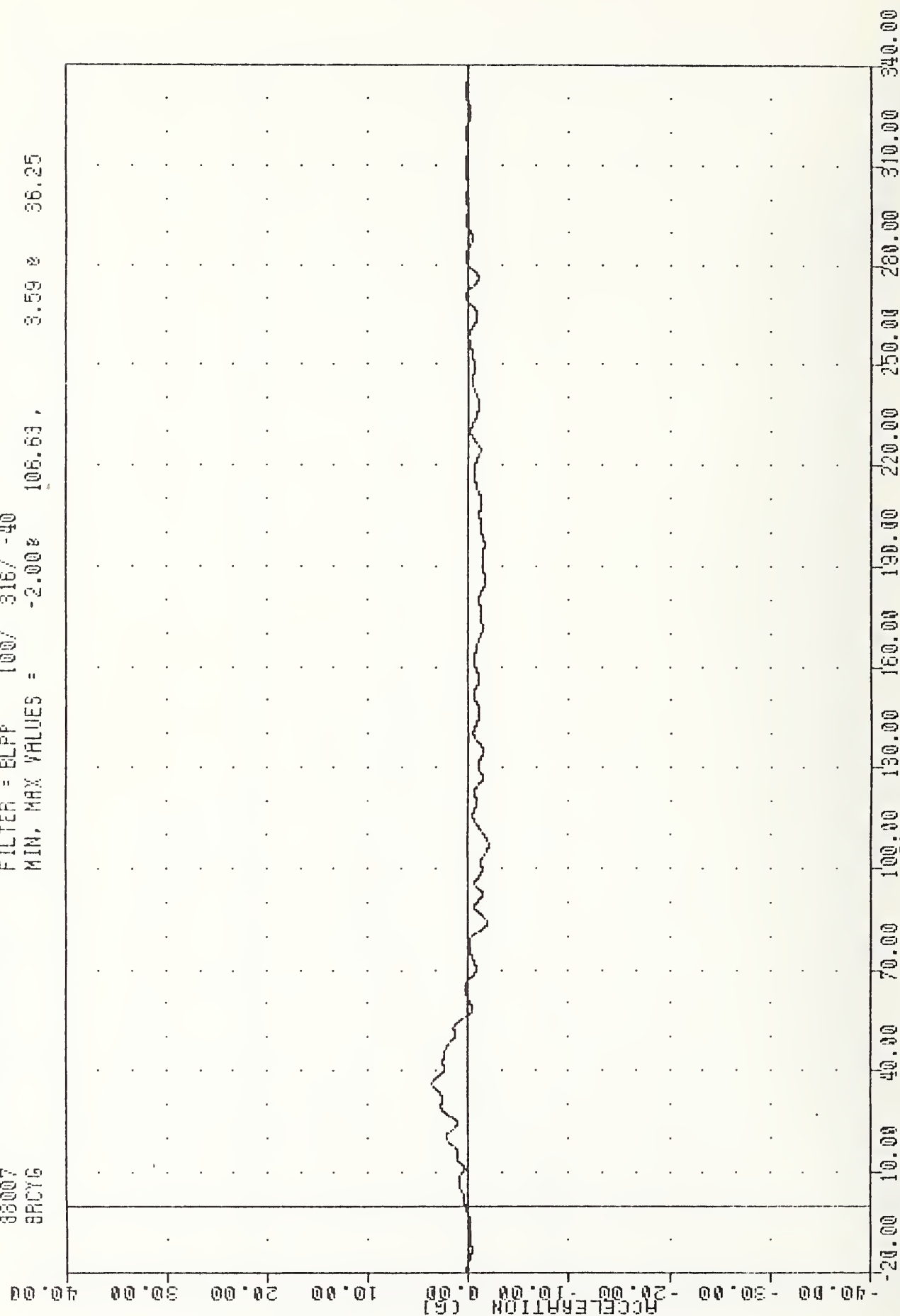


-20.00 10.00 20.00 30.00 40.00 50.00 60.00 70.00 80.00 90.00 100.00 110.00 120.00 130.00 140.00 150.00 160.00 170.00 180.00 190.00 200.00 210.00 220.00 230.00 240.00 250.00 260.00 270.00 280.00 290.00 300.00 310.00 320.00 330.00 340.00  
 MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
 DELTA V USING BRGXG



NRTC  
SI PROTECTION PASS VEHICLE  
88007  
BRCYG

FILTER = BLPP 100/ 316/ -40  
MIN. MAX VALUES = -2.00% 106.63, 3.59 % 36.25

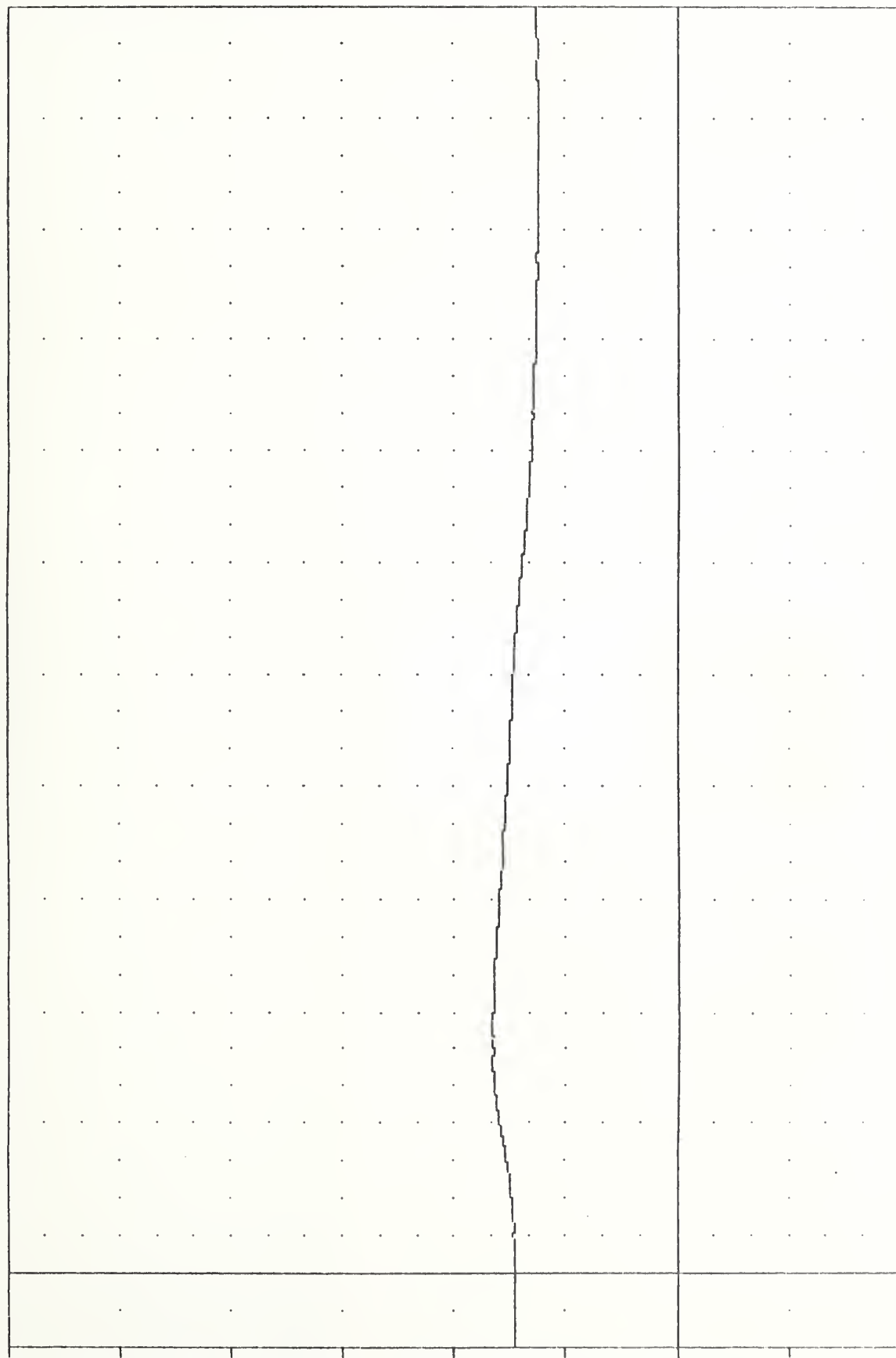


MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
BARRIER REAR CROSSMEMBER Y AXIS ACCELERATION

VRTC  
SI PROTECTION PROD VEHICLE  
88007  
BRCYV

FILTER = SLPP 300/ 949/ -40  
MIN. MAX VALUES = 12.40e 291.75, 16.61 e 56.13

VELOCITY (MPH)



MOVING DEFORMABLE BARRIER INTO 1985 CHEVROLET CELEBRITY  
DELTA V USING BRCYG



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